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Building the Mathis Dams--I

By E. Lauchli*

SYNOPSIS—First of two articles on the storage reservoir and dams of the Georgia Ry. & Power Co., supplementing earlier notes on the Tallulah Falls high-head hydro-electric development. Design of a reinforced-concrete dam with bulkhead, spillway and power-house sections. Unusual grouting of deep-lying fissured rock to prevent leakage.

The two reinforced-concrete dams at the Mathis storage reservoir of the Georgia Ry. & Power Co.'s Tallulah Falls development[1] are of unusual interest because of their features of design and methods of construction. A few brief notes on both aspects of the work are given herewith.

The Mathis reservoir is 10 mi. long and has a storage capacity of 1,335,000 cu.ft. It is located at Lakemont, Ga., some 6 mi. above the intake works of the Tallulah Falls plant. In order to dam the Tallulah River, it was necessary to throw across it a reinforced dam, 660 ft. long and 90 ft. high; and to close a depression leading out of the basin, a reinforced-concrete dam, 325 ft. long and 45 ft. high, was built a quarter of a mile downstream from the main dam. The location of both these structures is shown in Fig. 2.

The main dam comprises a short bulkhead section (east end), followed by a 290-ft. spillway section, then by a 60-ft. intake or power-house section, and finally by

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[1]For the design of the Tallulah Falls hydro-electric plant see "Engineering News," Jan. 29, 1914; for notes on construction difficulties see the issue of Apr. 16, 1914.

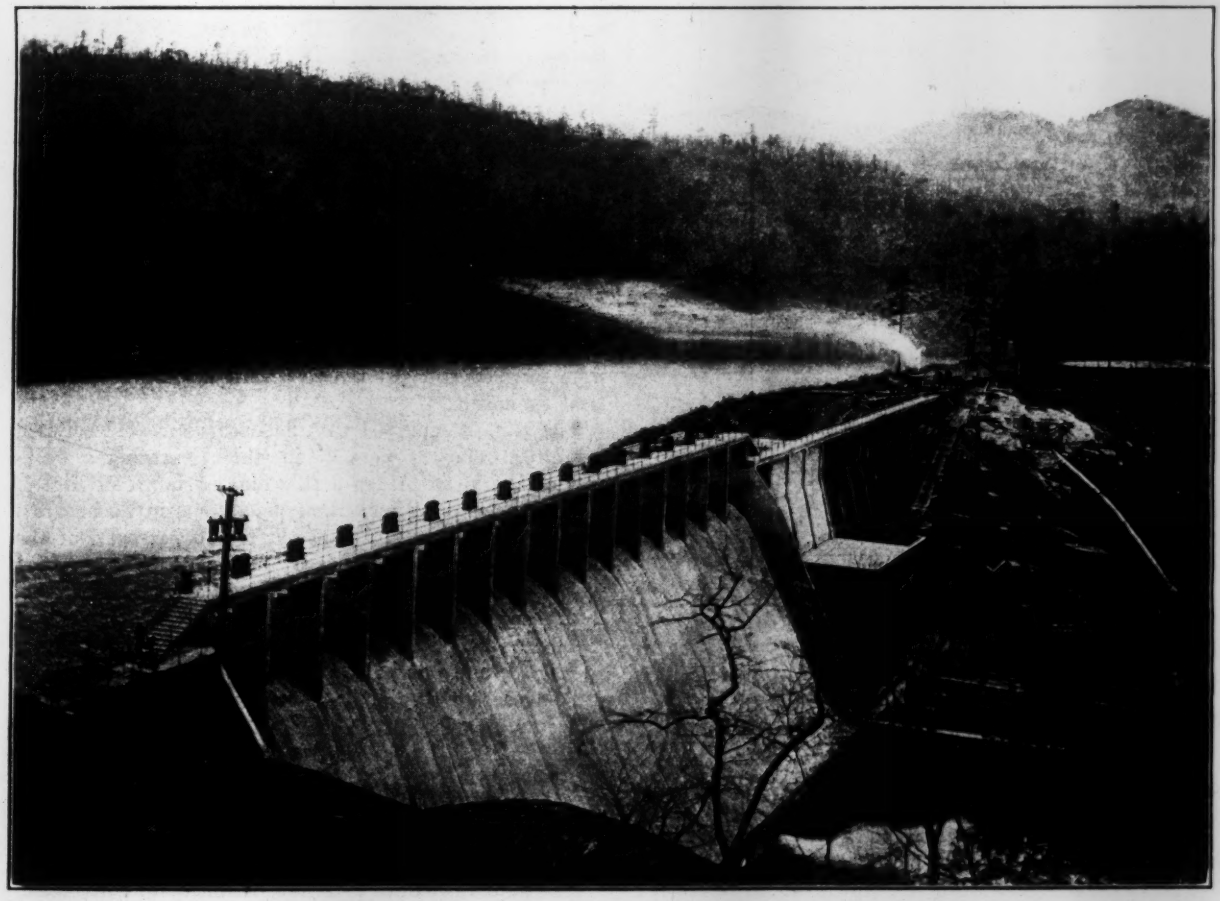

FIG. 1. REINFORCED-CONCRETE DAM AT MATHIS RESERVOIR

a second bulkhead section ending in a corewall carried into the hillside.

The spillway section consists of reinforced-concrete buttresses, 18 ft. c. to c., carrying upstream arched decks on a slope of 45 deg. with the horizontal, and aprons

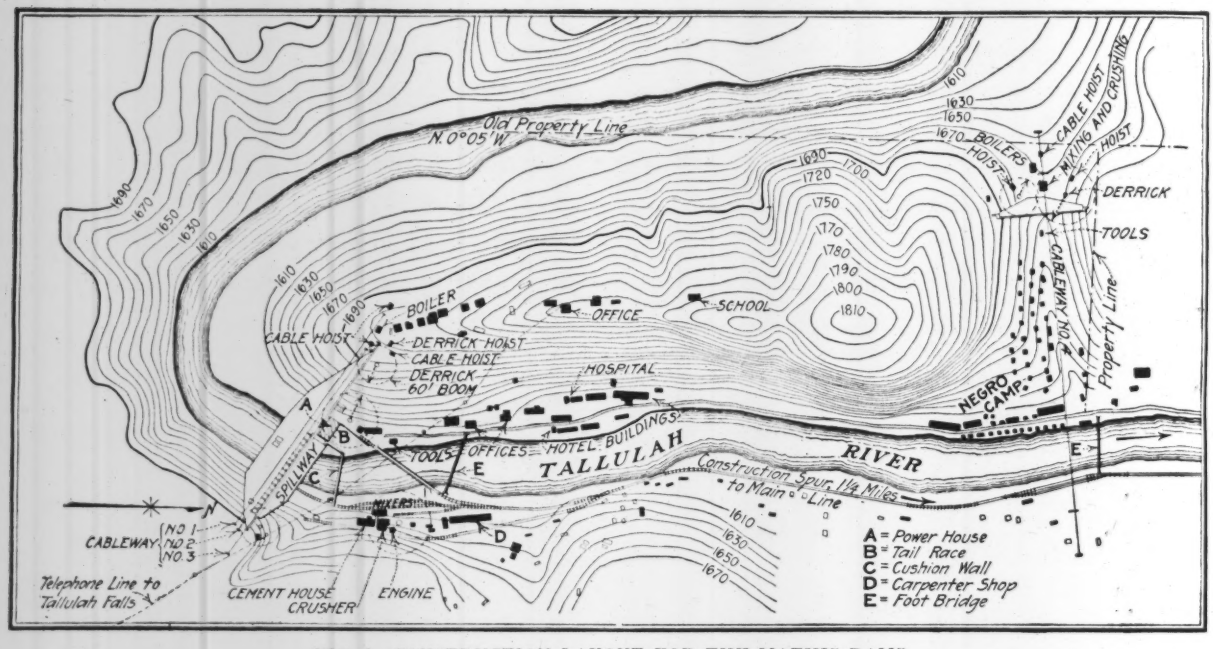

FIG. 2. CONSTRUCTION LAYOUT FOR THE MATHIS DAMS

on the downstream side, as shown in Fig. 3. The buttresses, to save material, were built in 12-ft. lifts, and decrease in thickness from bottom to top, and from the upstream to the downstream end. For instance, the lower lift of a buttress tapers from 40 to 32 in. and the upper lift from 24 to 20 in.

The spillway buttresses are reinforced horizontally at lift elevation and vertically at cross-strut points. Two walkways are provided through the buttresses, one near

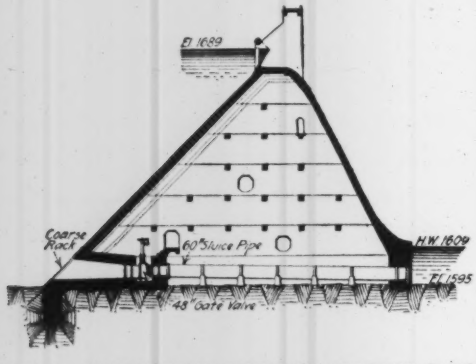

FIG. 3. SLUICEWAY SECTION, MATHIS DAMS

El. 1610, leading from the power house to the gate valves of the sluiceways, and one at El. 1655.

Decks, Aprons, Crest and Sluice

The decks consist of reinforced-concrete arched slabs, free to expand or contract horizontally. They have a rise of 18 in. at the crown and a crown thickness varying from 18 in. near the crest to 39 in. at the bottom, near the cutoff wall. The reinforcement is of 1⅛-in. corrugated bars placed 4 in. c. to c. at the bottom, the spacing varying at higher elevations according to the load carried. Near the crest the reinforcement is of 1-in. rods. Equalizing rods of ⅝-in. diameter are laid longitudinally, 24 in. c. to c. The decks were built in lifts corresponding to the buttress lifts, and keys were provided at the joints. Each deck rests on reinforced haunches cast with the buttress. To allow expansion and to insure imperviousness $\frac{3}{16}$x6-in. hair-felt strips were laid in hot asphalt at the seat, between the decks and the haunches.

The aprons on the downstream side are 18 in. thick from top to bottom, reinforced with 1-in. rods, spaced 7 in. c. to c., with equalizing rods running longitudinally. No waterproofing was provided between the apron slabs and the buttresses, but the abutting surfaces of each slab were tongued and grooved to permit horizontal and vertical expansion.

The crest is equipped with flashboards located between reinforced-concrete piers 26 in. thick, carrying a walkway or operating bridge 8 ft. wide, as shown in Fig. 5. There are seven Stauwerke-type automatic flashboards, capable of discharging 6000 sec.ft. (50 per cent. of the maximum recorded discharge) and nine hand-operated flashboards. All consist of leaves 16 ft. long and 7 ft. high, hinged at the crest of the dam.

There are three sluiceways, two at El. 1601, as shown in Fig. 4, and one at El. 1643, having a total capacity of 3500 sec.ft. with the pond at maximum elevation. Each sluiceway consists of (1) a tapered reinforced-concrete intake, protected by a coarse rack made of 35-lb. rails, 14 in. c. to c.; (2) a 48-in. gate valve operated by a 7-hp. electric motor, controlled from the power house; and (3) a 60-in. steel pipe ⅜ in. thick, carried on concrete piers.

The gate valves are of heavy design, with square bottom disks and heavy bronze guides. Heavy flaring cast-

ings, embedded in heavy concrete blocks, are provided on either side of the gate valve.

In order to protect the river bed from erosion, on the downstream side of the dam, a concrete submerged weir has been provided 100 ft. downstream from the spillway section, so as to form a water cushion, 14 ft. deep, in times of heavy floods. The weir wall, 3 ft. wide at the top, 7 ft. at the base, and 3.5-ft. high, is designed to

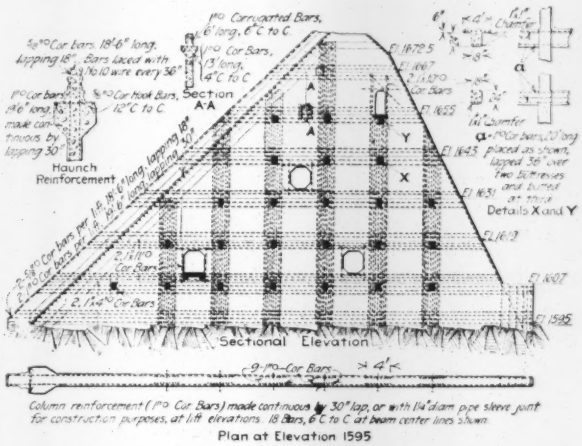

FIG. 4. SPILLWAY BUTTRESS DESIGN

have a low discharge coefficient. It is built on rock foundation throughout, and anchored every 18 in. with 1-in. rods.

Power-House Section

The power-house section of the dam is shown in Fig. 6. It consists of three bays, between buttresses spaced 20 ft. c. to c. Provision has been made for two 3000-kw. units. The power house is a brick building with steel columns on the downstream side, carrying the roof beams and the crane girders, the latter being carried at the upstream side of the power house on concrete brackets. The foundations and wheel-pits are of mass concrete.

There are two intake bays, each provided with stop-logs, fine-trash racks and 14x14-ft. steel headgates, with bronze guides, operated from a concrete platform at El. 1692. An 18-in. bypass has also been provided on each penstock to balance the pressure before hoisting the gate.

The bulkhead section consists of buttresses, of uniform thickness throughout a lift, placed 18 ft. c. to c. and without aprons on the downstream side, as shown in Fig. 1. The buttress footings were carried down to rock, with the exception of a few buttresses at the west end, which, on account of the extreme depth of bedrock, were given spread footings.

Throughout the dam a concrete cutoff wall was carried down to rock at the upstream side. Before laying concrete in the cutoff trench, drill-holes were put down

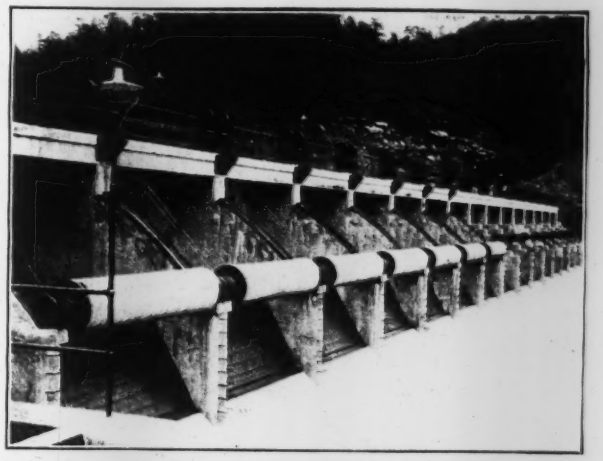

FIG. 5. AUTOMATIC FLASHBOARDS AT MATHIS DAM

at the bottom of the trench and then grouted under pressure.

In general these holes took little grout, except at the west end of the dam, where some trouble was experienced on account of the geological formation of the hill. Here the cutoff wall was carried down as far as 30 ft. below the original ground surface (see Fig. 7). From there on, to and beyond the dam, Lackawanna steel sheet piling 30 ft. long was driven through the material overlying the rock.

Grouting Fissured Rock

The location of the rock had been ascertained by driving 4-in. steel pipes (with water jet and by churning). In general it was found that the underlying rock was badly fissured and weathered. As there was some possibility that leaks would develop, about 3300 ft. of holes, 10 to 30 ft. deep, were put down with steam and air

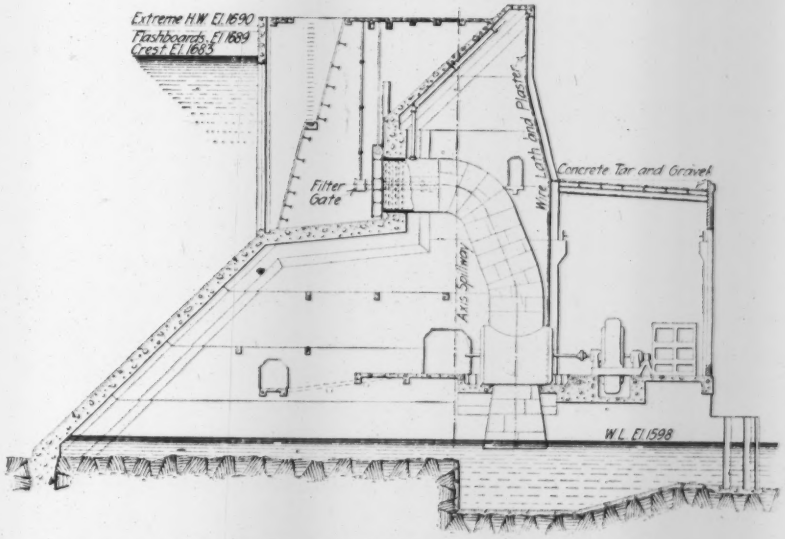

FIG. 6. SECTION THROUGH MATHIS DAM AT POWER HOUSE

drills and then grouted under 60- to 90-lb. pressure. About 2300 sacks of cement were thus used with a little sand added when the grout was absorbed too freely.

This, however, was not considered sufficient, as there was always the chance that a vertical hole would miss vertical seams. Therefore a shaft 50 ft. deep was sunk

at the west end of the dam, on the downstream side. As it was anticipated that drilling and grouting would be carried on while the reservoir was filling up, the bracing and sheeting was made strong enough to resist the full hydrostatic pressure. The shaft was driven through soft material easily picked for the first 40 ft. Below this elevation blasting had to be resorted to in order to excavate a working chamber 8x17x8 ft. The shaft was made 6x8 ft. in the clear and timbered with 10x10-in. posts and caps and 3-in. sheeting. The voids beyond the lagging were grouted. Diamond-drill holes varying in length from 50 to 290 ft. were put down at various angles, as shown in Fig. 7.

Some 1400 ft. of 4-in. holes were drilled, the bits giving a 3-in. core. Progress varied from 10 to 30 ft. per 24 hr. (two shifts), according to the hardness of the material penetrated. Frequently during drilling a flow of 3 or 4 gal. per min. would spout out of the collar of a hole, but no serious inrush of water ever occurred.

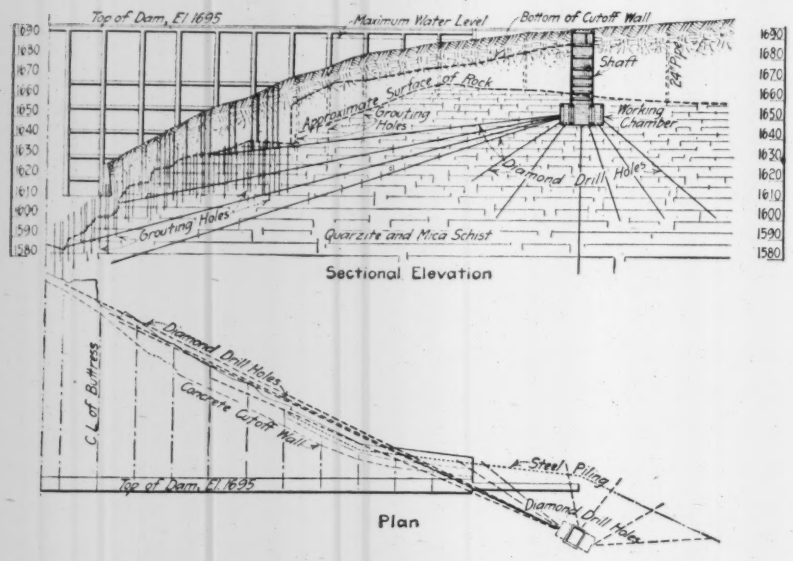

FIG. 7. DIAMOND DRILL HOLES FOR GROUTING FISSURED ROCK

With the reservoir at maximum elevation the total leakage into the shaft never exceeded 10 gal. per min. No bits or diamonds were lost. This work was done at a cost of about $4.50 per lin.ft. for drilling.

The holes were grouted under a pressure of from 60 to 80 lb. per sq.in. with neat cement grout mostly. Usually a hole would be drilled a short distance, and then grouted, then cleaned out and redrilled. A cement core could be recovered after 20 hr. when the hole was not cleaned out. About 29,000 gal. of grout was forced into the holes, the upper part of these absorbing more than the lower.

The total leakage at the west end of the dam never exceeded 200 gal. per min. with the reservoir at maximum elevation; it was finally reduced to a negligible amount.

Concrete Proportions and Stresses

The buttresses, piers and abutments were made of 1:3:6 concrete, the stone passing through 2½-in. mesh. The decks, crest, apron, beams and bridges were made of 1:2:4 mix, the stone passing a 2-in. mesh. The steel for the reinforcement had an ultimate strength of not less than 80,000 lb. per sq.in.

The following unit stresses were allowed:

	Tons per Sq.Ft.
Bearing power of rock for buttress footings	15
Bearing power of hardpan	3
	Lb. per Sq.In.
Buttresses, compression	300
Buttresses, direct shear	100
Deck and apron, compression	600
Deck and apron, tension	0
Deck and apron, shear	75
Steel reinforcement, tension	14,000

The structure required 23,700 cu.yd. of excavation; 33,600 cu.yd. of concrete and 1,908,200 lb. of steel reinforcement—about 56 lb. of steel per cubic yard—were used. The largest amount of concrete laid per week was 1073 cu.yd., and the largest weight of steel 87,400 lb.

Engineers and Contractors

The writer was in charge of the design of this dam and supervised its construction. C. G. Adsit was in general charge of construction work at the Mathis reservoir; with H. T. Hartwell as resident engineer. The late John Birkinbine was retained as consulting engineer. The whole Tallulah River development of the Georgia Ry. & Power Co. was designed by C. O. Lenz, Chief Engineer.

Gasoline Made by New Process

Much has been heard in recent months of processes for the production of gasoline fuel for internal-combustion engines out of heavier petroleum oils. Most of these processes seem to be modifications of the fundamental scheme to "crack" the heavier oils into the more volatile hydrocarbons with the deposition of excess carbon in the treating retorts. One process (described by the inventor, A. M. McAfee, before the American Institute of Chemical Engineers in San Francisco, Aug. 25, 1915) differs radically from these others in that high pressure is not employed on the stills and high-boiling oils are broken down into lower-boiling oils, which are sweet-smelling, water-white and saturated for hydrogen. Valuable heavy oils are produced as desired, and the carbon is deposited in a granular mass easily handled. The process has been tried out with success by the Gulf Refining Co., of Bayonne, N. J.

In practical operation, any kind of crude petroleum is distilled to remove gasoline and kerosene or to free it of moisture. Anhydrous aluminum chloride is added, and the mixture is brought up to boiling in a still with stirrer. The distilling vapors are held to 350° F. or under, to prevent the aluminum chloride passing over to the condenser. The distillate is a mixture of gasoline, solvent oil and kerosene which are later separated by fractionation. No treatment is given them except washing with alkali.

The results with a Texas crude oil show 17.8% gasoline, 13% gas naphtha, 8.7% kerosene, 17.1% gas oil, 25.6% lubricating oil, no asphaltic residue and a loss of 17.8%. The usual process yields 4.3% kerosene, 52% gas oil, 25.5% lubricating oil, and 12½% asphaltic residue.

Track Elevation at Lynn, Mass.

By Charles B. Breed*

SYNOPSIS—Projects for the elimination of grade crossings of the Boston & Maine R.R., at Lynn, Mass., included both track elevation and track depression. The former was adopted, at first for two tracks and later for four tracks. A feature of the work was the crossing of a public square in the center of the city. The bridges are of steel, with concrete decks, and have the columns and exterior girders masked with concrete. A concrete-arch viaduct runs through the station grounds. Some open-deck bridges have been given a solid floor of plank and roofing paper. The history and development of the project as now carried out are described, as are also the methods of carrying on the construction.

The city of Lynn, Mass., 11 mi. north of Boston, has a population (1915) of about 100,000, and an assessed value of real and personal property of $90,000,000. The Boston & Maine R.R. line through Lynn before its elevation was from 5 to 20 ft. above mean high tide. It was proposed to abolish eight crossings on the main line and seven on the Saugus branch, both double-track roads, with respectively about 150 and 40 regular trains daily. All of the crossings on the Saugus branch were grade crossings. On the main line, those in West Lynn were grade crossings, while all of the crossings from Central Square to the east had already been provided with highway overpasses, except at Chatham St. The situation is shown by the plan and profile, Fig. 1.

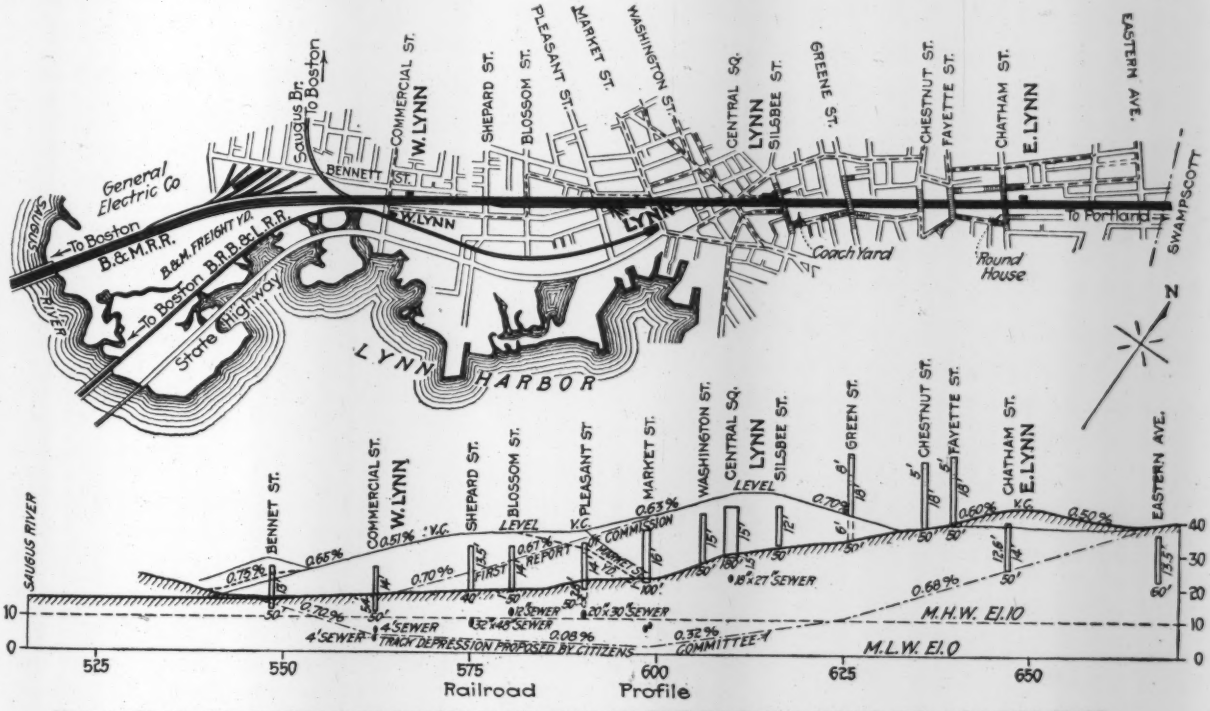

FIG. 1. PLAN AND PROFILE OF TRACK ELEVATION ON THE BOSTON & MAINE R.R. AT LYNN, MASS.

History of the Project

In July, 1901, the city engineer (the late George I. Leland) was instructed to prepare alternative plans for the abolition of grade crossings by depression and by elevation of tracks. His report showed that in 1901 at Central Square about 30,000 people and 2500 vehicles crossed the tracks daily, and that the gates were down about 3½ hr. between 6 a.m. and 11 p.m. At Washington St. about 7000 people passed, at Market St. 13,000, and at Pleasant St. about 5000. The gates were down at this last crossing for 7 hr. out of 17, and between 2 and 3 p.m. they were down 45 min. in the hour. In general this street was closed to traffic about half of the time, as it was located at the throat of the Market St. freight yard.

Five studies were made and estimated as follows: Main line elevation, $1,144,700; main line depression, $2,905,777; Saugus branch elevation, $418,320; Saugus branch depression, $635,875; Saugus branch relocation, $304,942. The city adopted the main line track-elevation plan. The railway also advocated track elevation; but its plan called for lower headroom and steeper approach grades on the streets, and for open-floor bridges throughout. Central Square is the industrial center of Lynn, the transfer point of all street-car lines, and contains the best business buildings. To have an open-floor railway viaduct 200 ft. long across Central Square was by no means desirable.

It was inadvisable to change the street grade to any extent at Central Square, on account of the value of the

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land and buildings. This resulted in an elevation of 18 ft. for the railway, bringing it to the grade of the Silsbee St. bridge over the tracks. The railway proposed to close this street and provide only a foot subway; but the city objected to this, as 14,000 people daily passed through Silsbee St. The city petitioned the Superior Court to appoint a special grade crossing commission, which made its report in 1906. It held that Silsbee St. should be closed, that public security and convenience did not require the immediate elimination of any crossings on the Saugus branch, and that two crossings on the main line could be left to a later time.

This report was opposed so strongly by the city that the Massachusetts Railroad Commission returned it for further consideration. The next report was made in 1909 and was the same as the first, except that it recommended the two extra crossings on the main line. In the meantime, however, the railway had agreed that a street in substitution for Silsbee St. should be built when necessity arose for it, the railway to pay 65% and the city

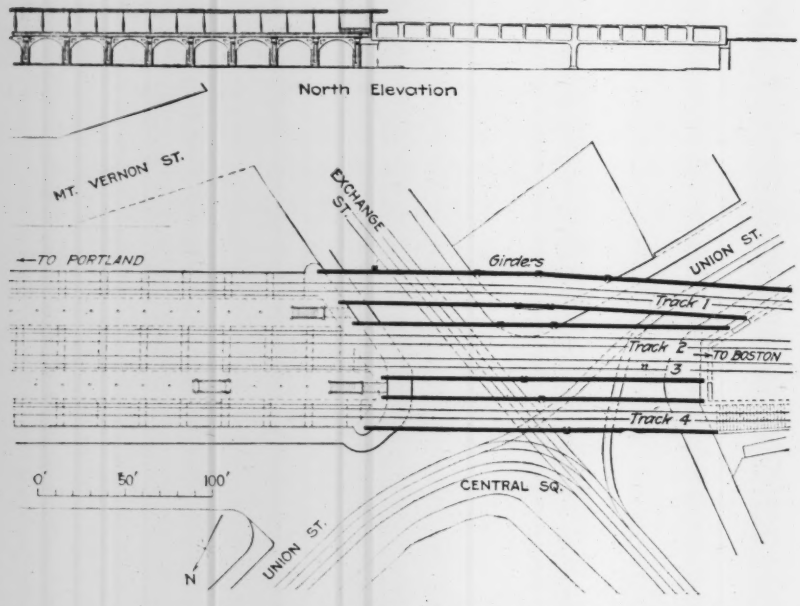


FIG. 2. CENTRAL SQUARE BRIDGE AND VIADUCT THROUGH STATION GROUNDS, LYNN, MASS.

35% of the cost. The Railroad Commission approved the report and the Superior Court made it a decree. Construction was started in September, 1909, at Commercial St. in the west end and at Chatham St. in the east end of the city.

About this time the New York, New Haven & Hartford R.R. obtained control of the Boston & Maine R.R. and proposed to four-track the line through Lynn, purchasing land for this purpose at a cost of nearly $1,000,000. To a committee of citizens Mr. Mellen, president of the railway, expressed himself in favor of track depression, were it not for the expense already incurred for track elevation. This was early in 1911. The municipal council then voted to assume the entire cost up to that date (about $624,000), and introduced a bill in the Legislature for a four-track depression project.

The railway company at that time estimated the cost at $4,495,000 for double-track depression and $1,412,000 for double-track elevation. The writer, representing the city, estimated the cost at $3,500,000 and $1,500,000 respectively. The railway alone was to pay the cost incidental to the two additional tracks.

The city's bill was not passed. The railway having purchased land for additional width of its location, as already noted, then proposed a bill modifying the two-track plans provided for by the court decree so as to allow for four tracks. The city took this opportunity to require that the construction, headroom, street approaches and bridges should be satisfactory to the city. The new act was drawn up jointly by representatives of the railway and of the city, and was passed by the Legislature in 1912.

This act provided, briefly, as follows: (1) A four-track elevation, with grade practically in accordance with the report of 1909; (2) Silsbee St. to have a subway the full width of street; (3) solid-floor bridges to be used, except at five streets where the bridges already had been fabricated or erected; (4) new highway bridges to be built at Green, Fayette and Chestnut St., with brick paving instead of plank floors, and to be maintained forever by the railway; (5) the bridges at Market, Washington, and Silsbee St., and Central Square, and the steel viaduct through the station grounds to have the girders and columns masked with concrete.

The Central Square bridge and the viaduct through the station grounds were required to be in accordance with a new plan which was presented with the act. This plan gave a minimum of columns in the square and a more attractive viaduct. It will be seen from Fig. 2 that the four tracks across Central Square are crossed by one double-track bridge flanked on each side by a single-track bridge, the lengths of span and positions of girders being accommodated to the street plan and street-railway track layout. Beyond this, a viaduct with arched spans extends to the station.

The act provided also that the railway should pay for all changes in overhead bridges and approaches east of the station, and that the cost of a two-track elevation should be divided among the railway, the city, the Commonwealth and the street railway company. All additional cost incidental to two extra tracks to be paid by the railway.

The Present Work and Its Cost

The work is now practically completed as a two-track elevation, but its expansion into a four-track line has not been fully accomplished owing to the financial condition of the railway. The total cost to date is about $3,000,000 (exclusive of the railway's additional right-of-way). About half of this is chargeable to the two-track system, and has been paid for as follows: The Boston & Maine R.R., 65%; the city, 10%; the Commonwealth, 17½%; and the Bay State St. Ry. Co., 7½%.

The expense to the railway, including its extra land for widening, will probably reach $3,500,000, which is a large outlay in view of the company's financial difficulties.

And unfortunately its benefits cannot be realized without additional expense. At Salem, 5 mi. east, is a single-track tunnel in the heart of the city. At Chelsea, between Lynn and Boston, the road has a double-track line with several dangerous grade crossings. It will cost about $6,000,000 to complete a four-track system from Boston to beyond Salem, where two important branches leave this division.

Fig. 1 shows a plan and profile of the work. The railway approached originally from Boston on the level and at 5 ft. above mean high water. From Commercial St. to Market St. it rose on a grade of 0.20%, and thence at 1% to Central Square. The latter grade was the maximum for the division and seriously affected freight traffic. It often caused very slow movements across the square, involving serious delays to street traffic (including fire-department delays). From the station eastward there was a rising grade of 0.32% for 2000 ft., followed by a level stretch. The other 1% grades can be eliminated at no great cost, and 0.7% is assumed as the maximum future grade for this division. The old alignment was followed.

The profile shows also the track-elevation project of the special grade-crossing commission (which was rejected) and the track-depression project of the city. The latter would have affected all the large sewers and lowered the railway nearly to low-tide level, requiring waterproof construction.

Methods of Construction

The general method of handling the work was as follows: At Chatham St. the two main-line tracks were first raised 6 ft. under traffic. Piles for two tracks were then driven and the tracks supported on the trestle. The street was closed to team traffic and the excavation was done by hand shoveling and teams. Many of the dwellings were so near the street line that they had to be shored, which was accomplished without settlement. When the two additional tracks were constructed in 1914, one on each side of the old double-track system, temporary trestles were first constructed across the street, and later replaced by permanent bridges. Typical views of the construction work within the city are shown in Fig. 3 with explanatory notes appended.

In the work at Commercial St., the tracks were first thrown far enough to the south to admit of constructing a two-track abutment. Then the street was excavated, and as this proceeded the tracks were also depressed to the grade of the new underpass, pedestrian traffic only being maintained on the streets. When the northerly half of the abutments was completed the traffic was turned onto the new elevation. A temporary runoff east of Commercial St. brought the elevated tracks to the old grade again at Shepard St. The next season the main-line tracks from Commercial St. to Market St. were thrown to the south far enough to permit the building of the retaining walls on the north side throughout this district.

These walls were partly constructed when work was held up on account of the introduction into the Legislature of an act which seemed destined to change the type of construction since it called for track depression. During this time the railway purchased a large amount of property between Commercial St. and Central Square, so that before work was resumed it was possible to demolish several buildings and to throw the tracks from West Lynn to Central Square still further to the south. This allowed not only the construction of the northerly wall but also the placing of filling adjacent to this wall sufficiently wide for two tracks.

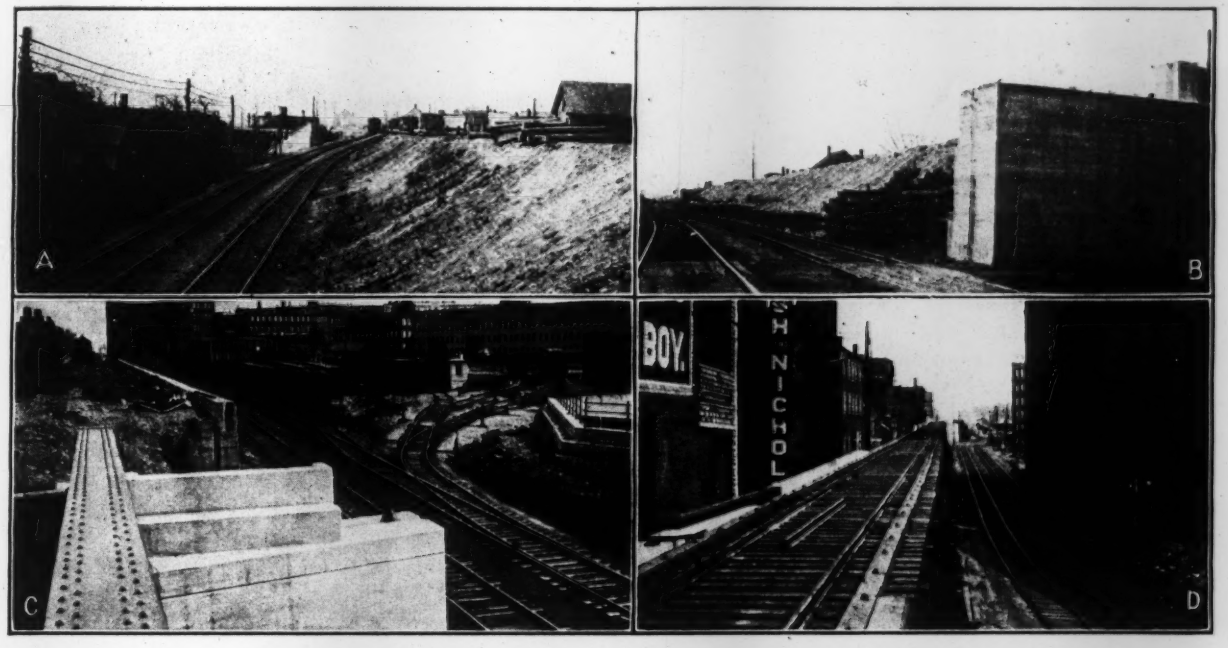


FIG. 3. TYPICAL VIEWS OF CONSTRUCTION WORK, BOSTON & MAINE R.R. TRACK ELEVATION AT LYNN

A—Looking west from Shepard St.; temporary low-level tracks at the left and elevation at the right. B—Looking west from Blossom St.; elevation completed for two high-level tracks. C—East from Pleasant St. bridge; two low-level tracks passing through the Market St. yard. The wall parallel with the track was part of the two-track elevation system (at the left) and was buried when this was widened to a four-track system. D—East from Market St.; two temporary low-level tracks and one track of the two-track elevated trestle. Top of retaining wall at the left.

The traffic tracks were moved south far enough between Market St. and Central Square to admit of constructing, not only the northerly wall, but also a two-track trestle (one track at a time) through this narrow district (Fig. 3). At Central Square the traffic tracks were thrown toward the south a considerable distance, which permitted the construction of a permanent viaduct

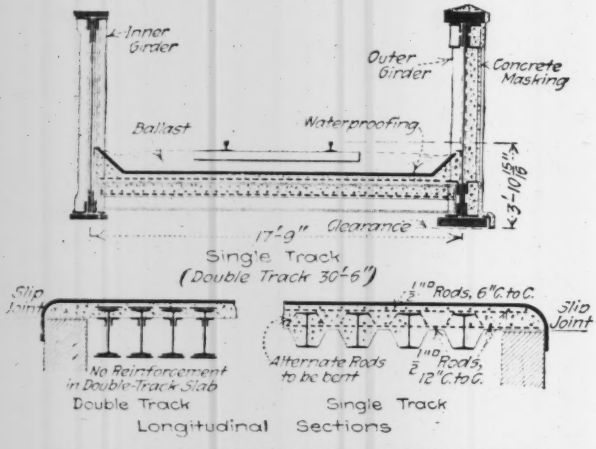


FIG. 4. SOLID FLOOR CONSTRUCTION; CENTRAL SQUARE BRIDGE SPANS

for three tracks from the Square through the station grounds to Silsbee St., and the runoff thence toward Green St.

By Aug. 9, 1913, all westbound traffic was carried on the elevated structure supported on permanent bridges or earth fill, except from Central Square to Market St. Then the trestle for east-bound traffic was constructed between Market St. and Central Square on the site of the old low-level temporary westbound track, and traffic was thrown onto the new elevated track. The temporary low-level tracks were then taken up, and the abutments at the various streets were extended to four-track width and the walls on the south side were constructed.

The widening out of the embankment was done from the eastbound traffic track. The fill between Market St. and Central Square was made from the trestle, principally at night and on Sundays on account of the large amount of regular traffic. The caps and stringers of the trestle only were reclaimed. The bridges on the main line were erected for two tracks before the traffic was turned onto the high level.

The runoff of the Saugus branch was raised entirely under traffic, both tracks being in operation during the construction. After the tracks had been raised to their full height, piling was driven at Bennett St., the excavation made and abutments constructed, while the railway traffic was carried on the two-track pile trestle.

Details of Bridges

All bridges were of the plate-girder type. The floor systems were field riveted. Seven of the spans in the Central Square bridge were 100 to 115 ft. in length; and the steel in this bridge weighed 1483 tons. Special derrick cars were used for handling these girders, the larger ones being placed at night.

Fig. 4 illustrates the type of floor for the solid-floor railway bridges. The concrete masking put on the outside girders is shown in Fig. 5. Much of this work was done during the winter time; steam coils were introduced into the forms, which were packed with straw to keep the concrete from freezing. The Central Square bridge floor had 674 cu.yd. of concrete and 1806 sq.yd. of waterproofing. The masking of the outer girders required 738 sq.yd. at the contract price of $4.25 per sq.yd. That on the Market St. bridge (Fig. 5) cost $935; Washington St. bridge, $493; and on the station viaduct and Silsbee St. bridge, $3638.

None of the bridges, except at Silsbee St. and Bennett St., had curb columns. In the former case they could not be avoided because the station platform extended across the street, so that the girders had to be shallow and therefore of short span. Bennett St. is in the outskirts of the city, near the new freight yard, and the city agreed to the cheaper construction in this place.

The remaining railway bridges were of open-floor construction, and under the act it was necessary to provide these with watertight decks. To meet this condition the railway constructed a watertight wood deck of special design on the steel flooring. The construction is shown in Fig. 6, but the floors have not been in use long enough to give conclusive evidence as to their success.

The ties are 7x10 in., 12 ft. long, with 4-in. oak blocks, carrying the track rails and guard rails. The open spaces are covered with two layers of tongued and grooved planking, secured by iron straps and screws. Between the two courses of planks are layers of felt, each mopped with coal-tar pitch. The openings at each side between the floor and the girders are closed by inclined sheathing in the plane of the gusset plates. This consists of two layers of ⅞-in. matched boards with a layer of roofing between them.

The highway bridges had steel floor-beams and wood stringers, carrying 4-in. hard-pine plank covered with

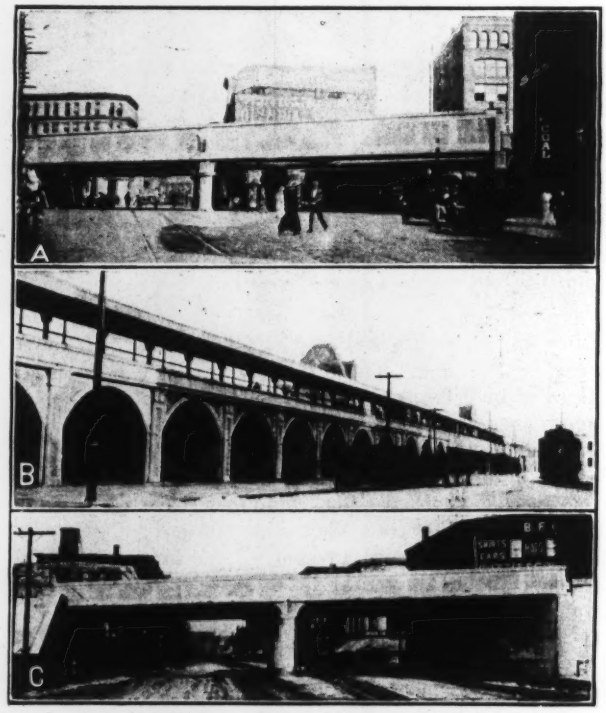


FIG. 5. TRACK ELEVATION STRUCTURES AT LYNN, MASS.

A—Steel bridge over Central Square. B—Concrete viaduct through station grounds. C—Steel bridge over Market St.

1½ in. of coal-tar pavement and waterproofing. On this was a 1-in. sand cushion for the brick pavement which was grouted with cement.

The bridges were constructed by the New England Bridge Co., Shoemaker Bridge Co., Boston Bridge Co., Phœnix Bridge Co., Pennsylvania Bridge Co. and American Bridge Co. The price for this steel work erected averaged 3.264c. per lb.

Concrete Work, Filling and Stations

The retaining walls and abutments were of gravity section, made with 1:3:6 concrete. No permanent piles were used on the project. The filling was principally sand and gravel, obtained from Peabody and Newburyport with hauls of 9 mi. and 27 mi. respectively. The gravel trains were equipped with air-operated dump cars, the spreading being done entirely by hand. There were practically no delays to regular train traffic throughout the entire period of construction.

The freight yards have been ballasted with gravel. The main-line tracks have stone ballast, hard-pine ties, Wolhaupter tie-plates, continuous rail joints and 85-lb. rails. There were only six private industry tracks leading from the main track. All of these were retained, some by building trestles on the owners' property and others by sidetracks on the railway right-of-way.

The filling was done by the railway company. The walls, abutments, station extension and viaduct arches were built and most of the street work was done under contract by T. Stuart & Son Co., of Newton, Mass. The Chatham St. project was carried through under a separate contract by the Farnum-Hanscom Co., of Boston. A few special contracts were let for remodeling the Lynn station and for special street pavement improvements. The unit prices paid T. Stuart & Son Co. on this work were as follows:

Excavation, earth, per cu.yd.	$0.50
Excavation, rock, per cu.yd.	2.50
Concrete masonry, plain 1:3:6, per cu.yd.	5.75
Concrete masonry, reinforced, per cu.yd.	7.25
Bar reinforcement in place, per lb.	.05
Waterproofing for arches (5-ply felt and 2-in. tar concrete), per sq.yd.	.85
Masking of bridges, per sq.yd.	4.25
Granolithic sidewalks, per sq.yd.	1.65
Furnishing and laying brick sidewalks, per sq.yd.	1.20
6-in. trap-rock macadam roadways, per sq.yd.	.60
Laying stone block paving, with sand joints, per sq.yd.	1.00
Grouting joints of stone block pavements, per sq.yd.	.20
Furnishing and laying first-class stone block pavement, per sq.yd.	2.85
6-in. concrete foundation for pavement, per sq.ft.	1.05
Manholes and catch basins, each	75.00
New curbstones in place, per lin.ft.	.90
Resetting curbstones, per lin.ft.	.20
6-in. sewer pipe furnished and laid, per lin.ft.	.90
8-in. sewer pipe furnished and laid, per lin.ft.	1.40
10-in. sewer pipe furnished and laid, per lin.ft.	1.60

The West Lynn and the East Lynn stations are small buildings built at the level of the elevated tracks and approached by stairs and inclined driveways. The Lynn station had originally two buildings, but the eastbound building was torn down and moved to another city. The westbound building was left at its original grade, and its main waiting-room was extended so as to pass under the elevated tracks, with stairway approaches to the island platforms. The extension of the waiting-room alone in this action cost about $51,000, whereas the total cost of station-building alterations, including new platforms, awnings, etc., was $106,000. This work was all done on a cost plus 10% basis, figured on the labor and materials, with no charge for plant or superintendence.

Parallel to and on the south side of the railway, between Central Square and Silsbee St., is Mt. Vernon St. (Fig. 2). This originally had an up grade of about 3½% from Central Square to the overpass at Silsbee St. The depression of Silsbee St. so as to pass under the railway introduced a hill with its summit midway along Mt. Vernon St. with a 3½% grade on each side. This hill was cut down, and a practically level street made, 50 ft. in width, which with the 20-ft. driveway in the station grounds resulted in a way 70 ft. wide. The city entered into a special contract with the railway in connection with this project, which included improved street pavements and some improvements in the station grounds. The city agree to pay 35% of the cost of that portion of the additional work which was done upon the street alone, including grade damages, and the railway agreed to pay the remaining 65%. The total additional cost of this project was $16,400.

Another special agreement was made between the railway and the city with respect to Bennett St. Originally this did not cross the Saugus branch, but the railway was raised to permit of extending the street. The railway agreed to pay for this additional raise and bridge construction, the city to pave Bennett St. from Commercial St. to the new freight yard.

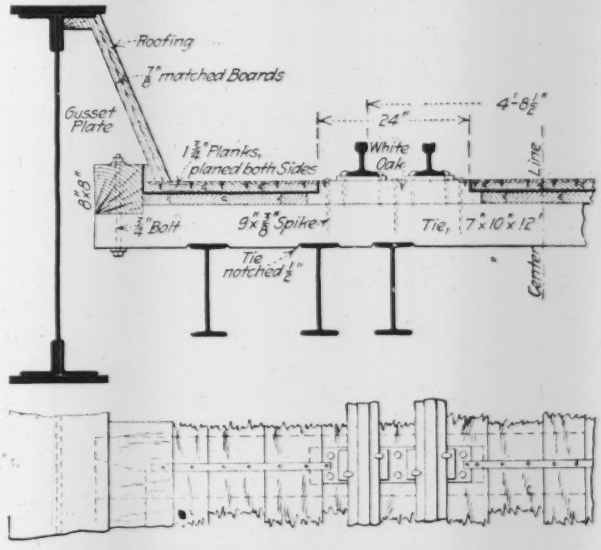


FIG. 6. WATER-TIGHT DECK FOR OLD OPEN-DECK BRIDGES IN LYNN, MASS.

Engineers

The work was done under three successive chief engineers of the Boston & Maine R.R.: H. Bissell, J. P. Snow and A. B. Corthell, the present Chief Engineer. The construction work was successively in charge of L. C. Lawton (now City Engineer of Haverhill, Mass.), F. C. Shepherd, Engineer of Construction of the Boston & Maine R.R., and G. L. Huckins, Division Engineer of Construction. The Resident Engineer for the railway was J. A. Parant. The bridges were designed by B. W. Guppy, Bridge Engineer of the Boston & Maine R.R. The Commonwealth was represented by H. W. Hayes, Chief Engineer of the Massachusetts Public-Service Commission. The Bay State Street Ry. was represented by David Curtin, Engineer of Maintenance of Way, and L. B. Reilly and F. B. Walker, Assistant Engineers. The municipality was represented by Wm. L. Vennard, City Engineer, and the writer, acting as consulting engineer.

Three Years' Growth of Street Traffic in Newark, N. J.

By Harland Bartholomew*

SYNOPSIS—Some interesting comparisons of traffic censuses made in 1912 and in 1915, showing the growth in vehicular traffic and the decreases in pedestrian and trolley traffic at Broad and Market St. accomplished by rerouting trolley cars.

Three years ago a traffic census was taken in Newark, N. J., chiefly with the end in view of effecting some relief to the traffic congestion at the corner of Broad and Market St., the city's main thoroughfares. A second similar census has just been completed, which offers many interesting comparisons and shows some of the relief effected. For an account of the 1912 census the reader is referred to the article by F. Van Z. Lane, in *Engineering News*, Sept. 12, 1912.

The police department has used and is using these censuses to regulate traffic and to determine points where traffic policemen are needed. The engineering department is using the figures in some instances as a basis for determining the type of pavement. The board of assessment and revision of taxes is using the data in making tax assessments. These uses of the traffic censuses are of course additional to those of the City Plan Commission, which made the counts with an aim to devising proper means for traffic distribution in the business section.

The completed count took approximately two weeks to accomplish with 30 special employees, although inclement weather conditions and torn-up pavements extended the time on a few counts one or two weeks longer. There were 107 places throughout the city where observations were taken for a period of 10 hr.—8 a.m. to 6 p.m. The observation points were upon thoroughfares where the greatest proportion of travel occurs. Counts were made always in the middle of the block to avoid confusion at street intersections and to observe accurately the total traffic passing through the street.

At each point note was made of the volume, character and direction of pedestrian and vehicular traffic. Vehicular traffic was classified according to character and weight, that is, whether the vehicle was drawn by one, two, three or four horses, with iron tires or rubber tires; whether it was a pleasure automobile or a small or large motor truck. Weights were determined according to whether the vehicle was empty, half full, or loaded.

*Secretary of the City Plan Commission, Newark, N. J.

Forms were provided for the enumerators so that all of these data were easily recorded. The field notes were tabulated upon daily sheets by the amounts of traffic in 15-min. intervals, so that it is possible to tell specifically the character and amount of traffic at any or all points during any period of the day.

Observations were not made on Saturdays, Sundays, holidays or on rainy days, thus avoiding abnormal conditions. The counts were also made at the same time of year as those of 1912 for equitable comparison.

An attempt was made to count for an entire week at one point in order to determine the daily traffic variation. Owing to extremely inclement weather conditions which prevailed last spring this was impossible. However, counts were made on seven different clear days at one point, and the results obtained are shown in Table I.

It will be noticed in this count that no great difference occurs in traffic on the different days, a maximum difference of 30% being noted in pedestrian travel on Monday and Tuesday. The counts for Saturday and Sunday do not compare favorably with those of the other days of the week. Monday is the heaviest day of the week in pedestrian travel.

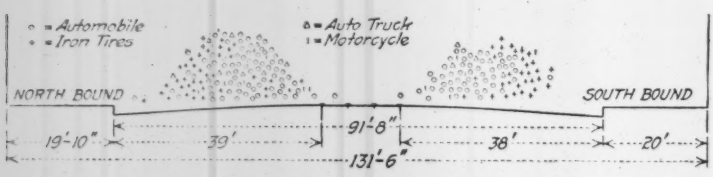


FIG. 1. TRAFFIC FOR ONE HOUR ON BROAD ST., NEWARK, N. J., BETWEEN COURT AND FRANKLIN ST.

Showing approximate distribution of traffic on the cross-section of the street—a new wood-block pavement

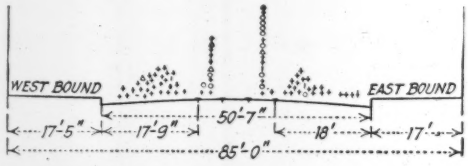


FIG. 2. TRAFFIC FOR ONE HOUR ON SPRINGFIELD AVE., NEWARK, N. J.

Showing distribution over cross-section with old granite blocks in poor condition

TABLE I. VARIATION IN DAILY TRAFFIC

Day	Date	Time Hr.	Roadway Traffic: Number Vehicles, Total	Roadway Traffic: Total Wt. of Vehicles, Tons	Sidewalk Traffic: West Side	Sidewalk Traffic: East Side	Sidewalk Traffic: Total Pedestrians
Sunday	4-18-15	10	1529	2614.50	872	562	1434
Monday	4-19-15	10	2402	4724.00	1241	571	1812
Tuesday	4-27-15	10	2402	4970.00	868	529	1397
Wednesday	4- 7-15	10	2061	4110.75	1164	598	1762
Thursday	4-29-15	10	2462	4036.25	1085	559	1644
Friday	4-30-15	10	1951	4053.75	1009	443	1452
Saturday	5- 1-15	10	2550	5031.75	810	569	1379

A chart was made showing the totals of each kind of traffic at the several observation points for 1912 and 1915, also the total increase or decrease and percentages of increase or decrease. While pedestrian traffic throughout the city increased 9.16 per cent., vehicular travel increased 23.84 per cent. These figures are an indication of increased activity despite the present business depression. According to the recent state census the population increased only slightly over 3 per cent. during this period.

Observation points showing an increase or decrease in excess of 30% in either vehicular or pedestrian traffic were plotted on a map to indicate their comparative locations. Of these, there were five points where pedestrian traffic decreased and 49 points where it increased. There were four points where vehicular traffic decreased and 35 points where it increased.

The points of excessive decrease in pedestrian traffic are explained by the rerouting of the trolley cars and interruptions to traffic because of construction work. The points of excessive decrease in vehicular traffic are all explained by increases on parallel thoroughfares because of new pavements or because of construction work. The many points of excessive increase in pedestrian traffic are the result both of rerouting trolley cars and of the normal increase of population. The points of excessive increase in vehicular travel are in consequence of new and better pavements and of the large total increase in vehicular traffic.

Table 2 shows the comparative counts of traffic at the intersection of Broad and Market St. in 1912 and 1915.

TABLE 2. TRAFFIC AT BROAD AND MARKET ST., 1912 AND 1915

Between	Vehicles		Cars		Pedestrians	
	1912	1915	1912	1915	1912	1915
Market St. (E.) Beaver and Broad St.	2,277	3,636	1,955	1,697	68,253	41,550
Market St. (W.) Halsey and Broad St.	2,252	3,261	1,517	1,664	77,036	72,556
Broad St. (S.) Mechanic and Market St.	4,052	6,052	1,097	1,245	52,109	53,547
Broad St. (N.) Bank and Market St.	4,210	5,974	1,535	1,255	82,493	72,071
Total	12,791	18,923	6,104	5,861	279,891	246,724
Percentage of increase or decrease		+47.99%		−3.98%		−11.85%

These results are doubly interesting since this is the busiest point in Newark and reputed to be one of the busiest corners in the country. The decrease in pedestrian traffic resulted from the recent rerouting of the trolley cars, while the increase in vehicular traffic was caused by the new wood-block pavement on Broad St. as well as by the normal increase of the city. The recent rerouting of the trolley cars was designed especially to relieve congestion at this intersection.

The actual decrease in pedestrian traffic at this point is not to be deprecated, since this corner long ago reached the saturation point, and the rerouting of the trolley cars has helped to spread the surplus traffic. Vehicular traffic at this point will undoubtedly continue to increase until other channels are provided for it.

The increases in all kinds of traffic verify the previous assertions of the City Plan Commission that the growth of the city is taking place chiefly to the south and west.

A comparative analysis of the total vehicular traffic in 1912 and 1915 is shown in Table 3, which also shows the actual number of each type of vehicle counted and the percentage of increase or decrease.

TABLE 3. TOTAL VEHICULAR TRAFFIC; 1912 AND 1915

	Iron Tires	Motor Trucks	Automobiles	Rubber Tires	Street Cars	Total
1915	69,471	15,322	72,463	7,342	43,483	208,081
1912	79,823	5,065	34,016	10,338	38,755	167,997
Inc. or dec.	−10,352	+10,257	−38,447	−2,996	+4,728	+40,084
Percentage	12.97%	202.51%	113.03%	28.98%	12.20%	23.840%

While the decrease in the number of horse-drawn iron-tired vehicles is at first rather surprising, it will be noticed that the increase in the number of motor trucks corresponds closely to this decrease, which is an indication that business is really on the increase, since a motor truck carries considerably more than the horse-drawn vehicle. The average weight of motor-truck traffic is 3.66 tons per vehicle as against 2.22 tons per vehicle of the horse-drawn type. Table 4 gives the total number and weights of motor trucks and iron-tired vehicles.

TABLE 4. COMMERCIAL VEHICLES AND WEIGHTS; 1912 AND 1915

	Iron Tires	Weights	Auto Trucks	Weights
1912	79,823	183,273.75	5,065	22,752.00
1915	69,471	154,428.75	15,322	56,128.25
Inc. or dec.	−10,352	−28,845.00	+10,257	+33,366.25
Percentage	12.97%	18.68%	202.51%	146.59%

Table 5 shows that a larger number of small motor trucks are evidently being used than formerly, since the average weight is decreasing.

TABLE 5. AVERAGE WEIGHT PER VEHICLE

	1912	1915	Difference
Iron tires	2.28 tons	2.22 tons	0.06 tons
Motor trucks	4.49 tons	3.66 tons	0.83 tons

The decrease in horse-drawn rubber-tire traffic, which is usually of the pleasure-vehicle type, is greatly offset by the enormous increase—113%—in automobile traffic, which includes runabouts, touring cars and limousines only. The count was completed before the advent of the so-called "jitney bus," some 200 of these having subsequently appeared in the city.

The increase in street-car traffic is a clear indication of added service (12%), which corresponds favorably with the total increase in pedestrian travel (9%).

The proportions of different kinds of vehicular traffic in the city in 1912 and 1915 is shown in Table 6.

TABLE 6. CHARACTER OF VEHICULAR TRAVEL; 1912 AND 1915

	1912		1915	
	Total	Per Cent.	Total	Per Cent.
Iron-tire	79,823	47.5	69,471	33.4
Motor trucks	5,065	3.0	15,322	7.4
Automobiles	34,016	20.2	72,463	34.8
Rubber tires	10,338	6.1	7,342	3.5
Street cars	38,755	23.2	43,483	20.9
	167,997	100.0	208,081	100.0

Innumerable conclusions could be drawn from a study of the figures at hand. A statement of general conditions and conclusions concisely stated follows:

Vehicular traffic in the city increased 23.84%.

Pedestrian traffic in the city increased 9.16%.

Trolley traffic in the city increased 12.20%.

Horse-drawn traffic, which decreased 12.97%, is being supplanted by motor trucks, which increased 202.51%.

Automobile traffic increased 113.03%.

Rerouting of trolley cars decreased pedestrian traffic at Broad and Market Sts. 11.85 per cent., while there were corresponding increases on Broad St. and Park Place in the vicinity of Central Ave., also at Market and Mulberry Sts. New pavement on Broad St. caused an increase of slightly over 50% in vehicular traffic on that thoroughfare.

Figs. 1 and 2 illustrate the approximate position taken by vehicles in two wide thoroughfares, one with a good pavement and one with a poor pavement. The designations indicate the center of the vehicle. Standing vehicles it will be noticed are responsible for lack of travel close to curbs. The illustrations are a clear indication of where the wear of pavement is to be expected.

E. P. Goodrich, of New York City, is consulting engineer of the commission; under his general supervision, the traffic work was in charge of A. B. Cozzens, assistant engineer, and the writer.

Material Rejected Under Test by the Pennsylvania R.R. System is reported for certain classes in a recent bulletin. The following table gives the acceptances and rejections in one year in six of the more important classes:

	Quantity Tested	Quantity Rejected
Steel castings (pounds)	77,700,000	500,000
Steel wheels (number)	128,000	4,000
Axles (number)	165,000	8,000
Bar iron (pounds)	150,000,000	6,000,000
Air brake hoses (number)	635,000	85,000
Cotton waste (pounds)	3,800,000	400,000

The total value of supplies, materials and purchased equipment tested and inspected in a representative year exceeds $80,000,000, and the cost of making these tests is a little more than one-half of 1% of that value.

Dominguez Central-Station Irrigation System

By Chester B. Loomis*

The irrigation system of the Dominguez Water Co. in southern California is an interesting example of central pumping-station development. The Dominguez Rancho, one of the old Spanish grants, about 14 mi. south of Los Angeles, contains approximately 20,000 acres of highly productive land. One part (*A* on accompanying map) was irrigated by individual electric motor- or gas engine-driven centrifugal pumps with a lift of not more than 25 ft. Another part (*B*) was partly irrigated by vertical gas-engine centrifugal pumps with a lift of from 75 to 125 ft. to the surface. Under some land (*C*) there are no water-bearing gravels at a depth that would allow of economical irrigation.

Considering the low lift and the long pipe lines necessary, it was found more economical to continue irrigation on the "*A*" lands as before and to install a system for the "*B*" and "*C*" lands only. During the preliminary work 4000 acres were sold for the industrial city of Torrance.[1] A stipulation was made that water should be supplied to the city by the Dominguez pumping station. No changes in the plans, beyond the design of the piping system, were required, as it is a well-known fact that when an agricultural district becomes a residential and manufacturing district, in general the same amount of water (say one miner's inch to 7½ acres) is required.

Wells and Canal

The water supply is taken entirely from wells and raised to the surface by air lifts. Steam-pumping engines serve the irrigation lines. Six wells (see map) lie east

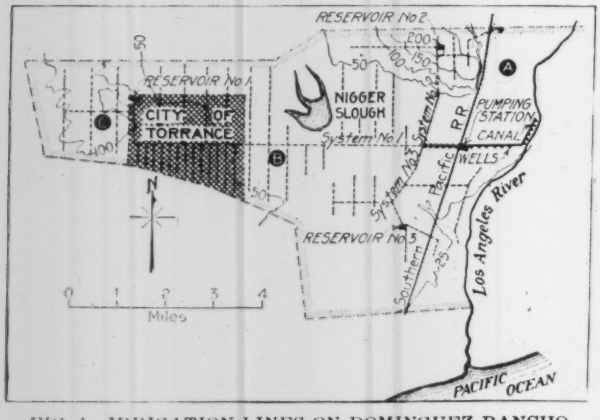


FIG. 1. IRRIGATION LINES ON DOMINGUEZ RANCHO

of the pumping-station site and a second line of six wells was drilled in a northerly direction along the bed of the Los Angeles river. The six wells on the east and west line from the station are shallow, being approximately 100 ft. deep with the water level standing from 10 to 40 ft. below the surface, depending on the season and pumpage. These wells were drilled 500 ft. apart, so that the cones of depression during pumping would not intersect except in case of excessive draft. The deep wells along the river bed average about 500 ft. in depth and flow approximately 200 gal. per min. each; but during pumping the level is lowered to approximately 30 ft. below surface. When pumping is stopped for about 36 hr. they again commence to flow. These six wells are also placed 500 ft. apart. All wells are 12 inches in diameter, cased with double No. 12 gage, red-iron stovepipe casing and were drilled with a standard California rig. The shallow-well casings, being in fine gravel and coarse sand, were given six rows of very narrow perforations equally spaced around the circumference. The deep-well casings are in coarse gravel and were given six rows of cuts ¼ in. wide. Each well was thoroughly sand pumped.

Over each well is a concrete box 3 ft. square by 5 ft. high (inside), the well casing projecting 18 in. above the concrete floor. From these boxes short pieces of 10-inch riveted steel pipe deliver the water into a concrete-lined canal, which extends from the farthest well to the pumping station sump. This canal has a fall of 2 ft. per mi. and increases in capacity from 10 sec.-ft. at the farthest well to 35 sec.-ft. at the pumping station.

This canal discharges through screens into a 250,000-gal. concrete sump, which acts both as a settling basin and a regulator for the pump supply. The sump is connected to the pumping station by a large concrete-lined tunnel.

Pumping Station

The pumping station is a reinforced-concrete structure 110 ft. long by 50 ft. wide and 23 ft. high to the bottom chord of the roof trusses. As there is no snow load and the roof has a pitch of 5 to 1, the trusses are of extremely light steel on 10 ft. centers. The roof is of galvanized corrugated iron. The exterior walls are paneled and finished in splatter-dash, making the building very attractive.

A right-angle extension of the sump tunnel, 4x6 ft. in section, runs along the wall nearest the sump. Short chambers open from it for the suction pipes of Pumps 1 and 2. This avoids blocking the tunnel with large suction pipes and keeps it out from under the pump foundations. All suction lines in the station, including those of the auxiliaries, take their water from this tunnel.

Boilers

There was no attempt at separate engine and boiler rooms, since with crude-oil fuel there is no dust or dirt. The boilers are installed across one end of the engine room. This leads to better attention, as they are always under the eye of the operating engineer. It also does away with the fireman, for the oiler can easily handle the fires in addition to his regular duties. The load is practically constant, and often the fires do not need attention for several hours at a time.

There are two water-tube boilers (standard Stirling type for 150-lb. working pressure) set in a single battery, with room for a single third boiler. This space is temporarily occupied by the machine shop. The settings are raised 1 ft. higher than standard to increase the volume of the combustion chamber.

The boilers are fired with crude oil under 40- to 50-lb. burner pressure. Each boiler has two front-fired burners (Wilgus type), set just inside the fire doors and throwing a fish-tail flame horizontally toward the bridge wall.

At first one boiler had two center-fired burners, designed by the writer, set in the center of the brick-covered grates. After careful tests the efficiency of the two types was found practically the same, except under very heavy

*Consulting Engineer, 419 Wilcox Building, Los Angeles, Calif.

[1]Described in "Engineering News," Oct. 30, 1913.

overloads, when the center burners showed up about 1½ per cent. better. The stack-gas analyses showed from 13.5 to 14 per cent. CO_2 under normal running conditions for long periods. As the plant load is practically uniform, the front-fired type was used on both boilers because of easier removal for repair and cleaning.

Fuel oil is delivered at the plant in tank cars; the tracks being high enough for gravity unloading. A permanent 7⅝-in. line is laid underground from the railroad to the station tank, which is of reinforced concrete, 25 ft. in diameter by 10 ft. deep. All that is necessary to unload a car is to screw a large funnel into the delivery line, spot the car discharge over the funnel and open the valve. The station fuel pumps take their supply directly from the storage tank. In case the oil in the station tank is too cold to be handled by the fuel-oil pumps, it may be heated around the pump suction pipes by steam coils.

Air Compressors and Pumping Engines

Two single-stage air compressors (14- and 27x19x24-in. cross-compound condensing) supply the well air lifts. Cooling water for the condensers is drawn from the suction tunnel and discharged into the sump outside. The compressors have mechanically operated inlet and automatic exhaust valves, automatic lubrication, pressure governors, safety stops, reheating receivers, etc. The air inlet pipes lead vertically upward through the roof.

There are three pumping engines, each being normally operated under a different head; but the designs allow two pumps to serve each one of the three irrigation systems, thus preventing water shortage due to the breakdown of any unit.

Pump 1 is a 16- and 34x16x36-in. cross-compound condensing Corliss-type crank-and-flywheel high-duty engine, with outside center-packed water ends. It is equipped with a combined speed and pressure governor, suction condenser, direct-connected suction valveless air pump, automatic lubrication, etc. This pump normally operates against a head of 139 ft., but is capable of delivering water into Line 2 against a head of 250 ft.

Pump 2 is similar to Pump 1, except in the water end, though this is also outside center packed. This pump is 16- and 34x12x36-in. and operates normally against a 250-ft. head.

Pump 3 consists of an impulse steam turbine driving two 8-in. centrifugals through reduction gearing (all De Laval machines). These pumps work against a 60-ft. head at 1500 r.p.m. The turbine exhausts into a jet condenser which takes cooling water from the suction tunnel and discharges back into it. By this scheme a long and complicated condenser discharge pipe is avoided, and by proper position of the condenser discharge lines the water in the tunnel is not raised perceptibly in temperature.

Auxiliaries

The auxiliaries consist of two 7x4½x10-in. boiler-feed pumps, a 500-hp. open feed-water heater, a fuel-oil pumping set (comprising two 4x3x4-in. duplex pumps mounted on a stand together with an oil heater and pressure regulator), a 10-kw. 110-volt direct-current generator, direct connected to a vertical high-speed engine taking steam either from the main boilers or from a 15-hp. vertical-boiler outfit which is complete with feed pump and injector. The little boiler can be fired either with wood or oil and is used particularly to furnish steam for atomizing the fuel oil when starting up the main boilers and to operate the 10-kw. generator when the main boilers are shut down and night work is to be done.

The machine shop contains an 18-in. swing lathe and a 48-in. drill press, driven by a gasoline engine. When the third boiler is installed the machine shop will be removed to the building now occupied by the blacksmith shop and storeroom; but it is at present more convenient to have the shop where the engineer can attend to the work while the plant is in operation.

Irrigation Lines

Irrigation Line 1 is served by Pump 1 and consists of a 33-in. riveted steel force main approximately 8 mi. long discharging into a 20,000,000-gal. reservoir. The reservoirs on all three lines are in earth and are lined with crude oil well worked into the dirt. This makes a very satisfactory and completely water-tight lining. From the force main laterals are run out at right angles every 2000 ft., so as to cover all the lands served by this particular line. These laterals vary in size according to the hydraulic head, so that each one has the same discharge. The outlets on this line and also on Line 2 all have standard 4-in. iron-body brass-mounted gate valves.

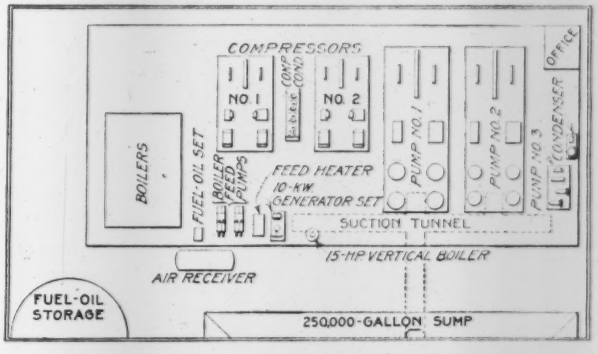


FIG. 2. LAYOUT OF DOMINGUEZ PUMPING STATION

Line 2 is served by Pump 2 and consists of a 20-in. riveted steel force main delivering into a 7,500,000-gal. reservoir. Owing to the topography of the land served by this line it was not possible to run laterals from the force main, so trunks were run from the reservoir and laterals from these trunks. Line 3 is served by Pump 3 and consists of a 20-in. riveted steel line delivering into a 7,500,000-gal. reservoir. Laterals are run from the force main and from trunk lines out of the reservoir. On account of the elevation of certain portions of the land served by this line the reservoir is so piped that it may be bypassed and the irrigation water pumped directly on the land.

All water consumers on the various systems purchase their water through meters, these meters being checked by Venturi meters at the pumping station.

This plant was designed and installed by the writer and has been in operation now for two years. It has proved very efficient and reliable.

Inexpensive Electric Service for unwired dwellings is being promoted by the Louisville (Ky.) Gas & Electric Co., by offering a low-priced panel board for service in one room. A steel panel carries a meter and a two-socket receptacle. A 12-ft. cord and a 60-watt tungsten lamp is included in each outfit. A light and a fan or a flatiron, or any two current-drawing devices, can be used at one time. The rest of the house may be wired starting with this panel as a base, and it is expected that many installations will grow in this way.

A Generalized Form of Hooke's Law

By E. R. Hedrick*

It has been known for a long time that many materials fail to satisfy Hooke's law exactly, even within the range usually described as below the elastic limit. Even such substances as steel and wood have measurable variations from this law that have long been recognized by physicists and engineers.[1] Other substances, such as cast iron, concrete, bronze, copper, stone, rope and so on, depart from the law very widely indeed.

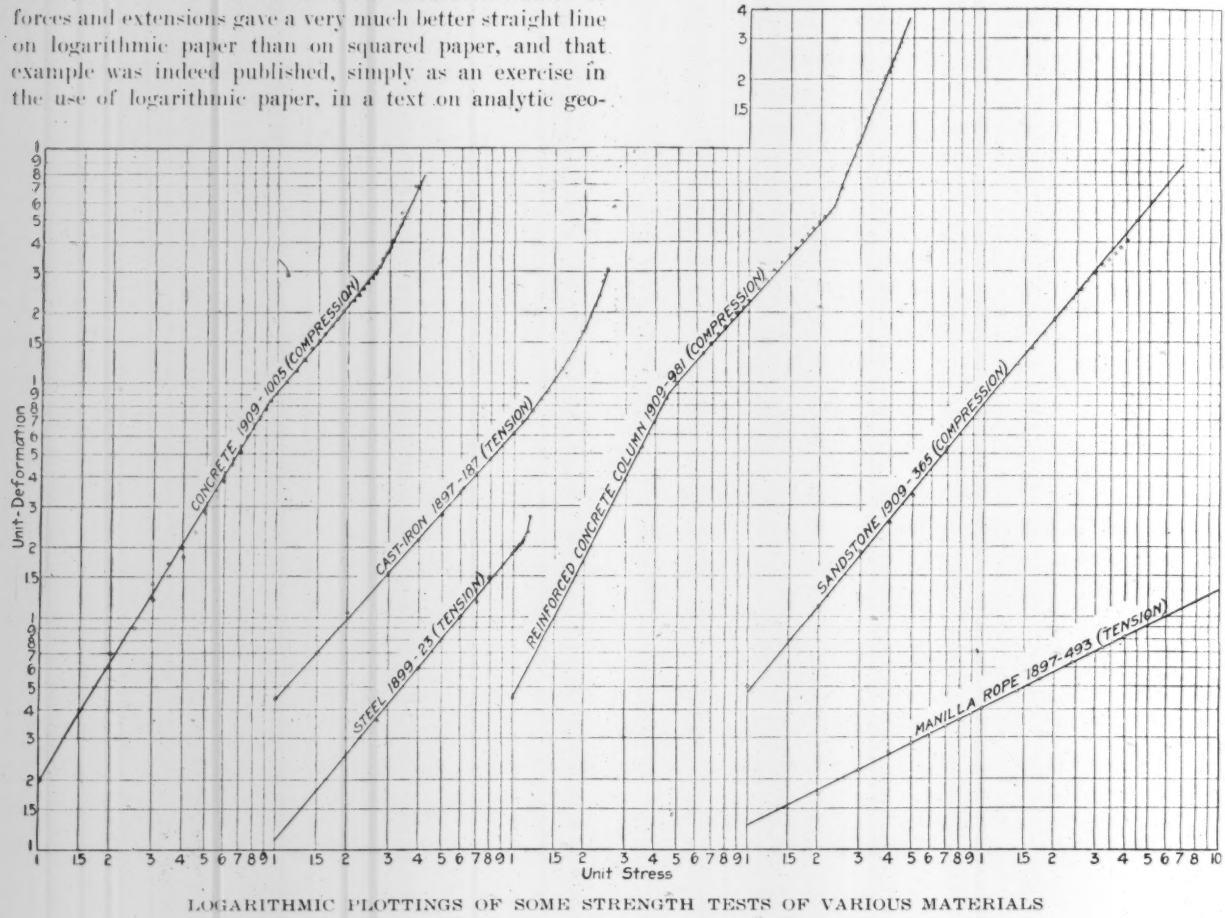
The writer discovered originally for a set of data on the extensions of rubber that the measured values of forces and extensions gave a very much better straight line on logarithmic paper than on squared paper, and that example was indeed published, simply as an exercise in the use of logarithmic paper, in a text on analytic geometry with which the writer was connected.[2] This means, of course, that the relation between the force p and the extension e is in that example much better expressed by a relation of the form

$$p = ke^n \qquad \text{or} \qquad e = cp^{\frac{1}{n}} \tag{1}$$

if n is taken *different from unity.* In the example just mentioned the value of n was found to be approximately 0.625.

It seemed less likely that other substances would show any similar behavior; but it at least suggested itself that a comparison would be illuminating, if for no other purpose than to bring out the contrast between rubber and other substances. For this purpose I have been working over the data contained in the Reports of the Watertown Arsenal, in which the numerical results of the actual tests of a large number of substances are given. Contrary to my original expectation, I soon began to suspect that the effect noticed in the example mentioned is not peculiar to rubber, but occurs also with many other substances.

I have now worked over a substantial part of the tests in several of the volumes of the Watertown Reports, and I think it is safe to announce that these results follow a straight line on logarithmic paper[3] better than they follow a straight line on squared paper, in a very large number of cases.


Unit-Deformation
Unit Stress
CONCRETE 1909 - 1005 (COMPRESSION)
CAST-IRON 1897 - 187 (TENSION)
STEEL 1899 - 23 (TENSION)
REINFORCED CONCRETE COLUMN 1909 - 981 (COMPRESSION)
SANDSTONE 1909 - 365 (COMPRESSION)
MANILLA ROPE 1897 - 493 (TENSION)

LOGARITHMIC PLOTTINGS OF SOME STRENGTH TESTS OF VARIOUS MATERIALS
References are to "Tests of Metals," Watertown Reports

For steel, of which the tests are most numerous, the value of n is quite close to unity, but it is in most instances very definitely different from unity, and there are specimens[4] that give values as low as 0.69. The majority of specimens of steel give values of n over 0.85, but many specimens give values less than 0.9.[5]

Some other substances give values of n near to unity. Thus, an excellent specimen of long-leaf yellow pine, under compression, follows a straight line on logarithmic paper with remarkable fidelity, and gives a value not far from

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[1]See, e.g., Thurston, "Materials of Construction," pp. 346-347; U. S. Board, 1881, pp. 217-221; Poynting and Thompson, "Properties of Materials," p. 53; etc.

[2]Ziwet and Hopkins, "Analytic Geometry," p. 275.

[3]The proper initial extension for the initial load must be determined by trial of several logarithmic plottings.

[4]"Watertown Arsenal Reports," 1897, p. 317.

[5]Watertown, 1899, pp. 23 to 47 and p. 163.

0.95.[6] Other specimens of wood show greater divergence; thus, a piece of fir, across the grain,[7] gave $n = 0.85$, approximately.

Other substances show still great divergences. Thus, a specimen of cast steel (Watertown Reports, 1899, p. 351) gives $n = 0.74$. Two specimens of cast iron (1910, pp. 161-2) give 0.69. Several specimens of copper (1907, pp. 78-81) give a set of remarkably parallel lines that correspond to 0.56. A specimen of sandstone (1907, p. 365) gives 0.80.

A case that is worthy of mention is that of rope. A piece of manila rope (1897, p. 493) gives a very good line for $n = 1.94$. Confirmatory evidence that this case is not accidental is to be found in the same volume.

The behavior of concrete, both plain and reinforced, is very remarkable. Evidently, a further study of this important substance is desirable, as will be seen if an attempt is made to draw the corresponding lines. Throughout long ranges of values the pressures and compressions follow a straight line on logarithmic paper. These lines take suddenly a different direction, as will be seen in a most pronounced fashion if even a hasty sketch is made of the test in Watertown Report 1909, pp. 981-982, in the range from 1000 lb. to 4400 lb. per sq.in.,

An interesting confirmation is afforded by the tests on the strength of iron girders conducted by the United States Board and reported in detail on pages 217-259 (Report, 1881). The variation from theory noticed by the board (pp. 217-220), which appears prominently in the numerical data and in the large graph inserted near page 281, seems to check with what would be expected from the theory proposed in the present paper. The numerical data plot as straight lines on logarithmic paper up to the elastic limit in the case of every beam measured by the board. The elastic limit itself shows very strongly on the logarithmic graphs, and it would appear from certain remarks appended to the report that uncertainty remained in the minds of the board in several instances which are perfectly determinate on the logarithmic graphs. The formulas for the deflection d produced by a center-load w are

$$d = Kw^n \quad \text{or} \quad w = Cd^{\frac{1}{n}} \qquad (2)$$

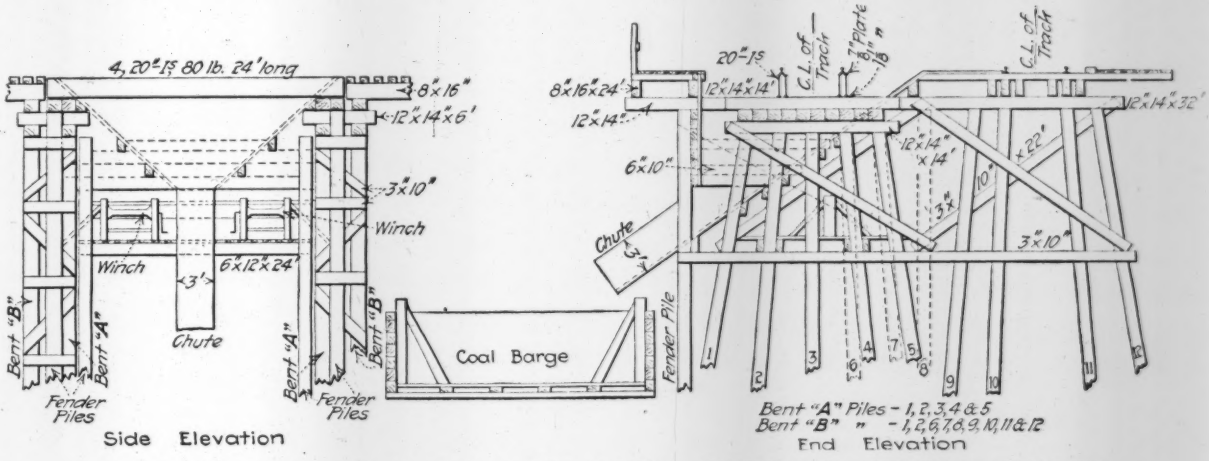
where n varies from a trifle less than 1 to a minimum of 0.74 (see page 240) for this set of tests. It will be remarked that this range of values is practically the same as that found for direct-tension experiments. These formulas agree with beam formulas which I have deduced on assuming that eq. (1) holds for direct tension and compression.

[6]Watertown, 1897, p. 420.
[7]Watertown, 1896, p. 386.

River Terminal at East St. Louis

The Alton & Southern Ry. is a new 15-mi. belt line which serves a large portion of the industrial district at East St. Louis, Ill. It connects with nearly all the railways entering this district and has a water terminal (known as the Fox Terminal) on the Mississippi River just south of the city, near Carondelet. This was mentioned in an article on "Port Improvements Along the Mississippi River" in *Engineering News*, June 3, 1915.

The terminal has a double-track timber trestle 1400 ft. long, with an average height of 20 ft. above the water. This can accommodate barges on both sides. Lumber and heavy freight are handled between barges and cars by a 50-ton locomotive crane, having a hoisting capacity of 20 tons. Package freight is delivered from pier to barge by spiral chutes, and is handled from the barges by the crane, the freight being placed in slings.



FREIGHT PIER AND COAL HOPPER OF THE ALTON & SOUTHERN RY., AT EAST ST. LOUIS, ILL.

Special facilities are provided for shipping coal, and it is expected that a large traffic in Illinois coal will be handled in this way. The coal is delivered at the pier in railway dump cars and discharged into a track hopper, from which a hinged spout delivers it into the barge. At high water, when there is not enough fall for this gravity chute, the coal is carried from the hopper by a conveyor on a boom. During the first month's operation about 3000 tons of coal and 10,000 tons of bauxite were shipped from this pier.

The terminal has about 3400 ft. of track, with accommodation for 10 cars on the pier and storage room for 50 cars, so that freight can be handled promptly. The facilities provided are in excess of present needs, and are so arranged as to allow for enlargement with the expected increase in the water-borne freight traffic. The cost was about $50,000. E. S. Fickes is Chief Engineer of the Alton & Southern Ry., and for information and plans we are indebted to him and to W. N. Aubuchon, Jr., manager of the East St. Louis Association of Commerce.

5000-Hp. Chain Drive for a Hydro-Electric Plant

The Ox-Bow hydro-electric plant on the Snake River, in Oregon, has the distinction of possessing the most powerful chain-drive gear in the world. This feature was not intended in the original design, but was introduced to adapt existing machinery to modified conditions and plans. The plant is owned by the Idaho-Oregon Light & Power Co., and is located about 50 miles north of Huntington, Ore. It has been in operation for some months.

The location is at the downstream end of a sharp bend or loop in the river. The original project provided for a tunnel across the neck of land, the tunnel being about 1160 ft. long and 26 ft. diameter. The floor was 10 ft.

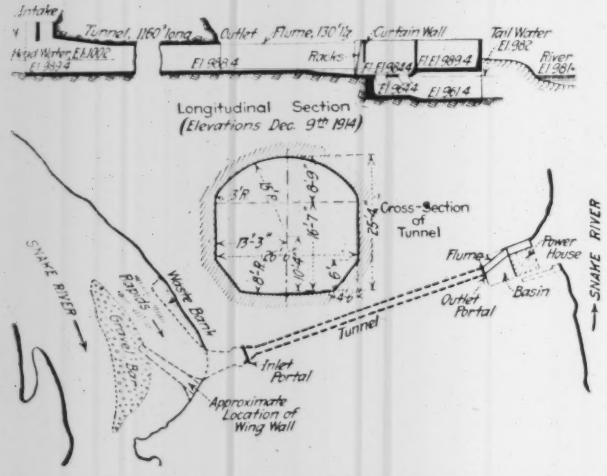


FIG. 1. PLAN AND LONGITUDINAL SECTION OF THE OX-BOW HYDRO-ELECTRIC PLANT ON THE SNAKE RIVER, OREGON

below low water at the intake end, and had a fall of 1:1000. This gave a natural head of from 20 to 22 ft., depending on the stage of the river, and was little affected by flood- or low-water conditions. This is shown in Fig. 1. In addition, a diversion dam was to be constructed about 1000 ft. below the tunnel intake, raising the headwater level 30 ft., and thus affording about 50 to 52 ft. head.

The power plant, at the lower end of the tunnel, was designed for the installation of six units, each consisting of two pair of 48-in. waterwheels operating in open flume through center-discharge shaft tubes and direct-connected by flange couplings to a 3600-kw. alternating-current three-phase 60-cycle generator running at 225 r.p.m. The plant was also to contain two 250-kw. direct-connected exciters operated by independent waterwheel units.

Financial difficulties necessitated the stopping of construction when the tunnel had been finished, except for the openings from the headgates in the river. The power-plant foundations had been completed to the floor level in two units and to the spring line of the arches which were to support the floor in the remainder of the plant. Machinery had been purchased and the waterwheel apparatus delivered for three units, as was also the structural steel for the entire power plant. The dam to give the intended head had not been built. This condition continued for several years until the appointment of a receiver in December, 1913.

The receiver and the bondholders of the company employed Prof. John R. Allen, of Ann Arbor, Mich., and W. H. Rosecrans, consulting engineer, of Chicago, to examine the condition of the property and suggest some means of developing power.

With the low head available (20 ft. instead of 50 ft.), and the consequent reduction in power, the turbines could not be run at the speed required for the generators. But as the machinery had been delivered it was desirable to utilize it rather than order new equipment. Direct connection being out of the question, some form of gear transmission was considered, and the engineers recommended the installation of a single unit composed of two waterwheels and one generator, with a chain-drive transmission. This plan made it possible, with comparatively slight changes, to use the machinery already purchased. The expense was much lower than by another system of development, and only a small proportion of this expense would be lost if the plant should be altered later in accordance with the original plans.

The arrangement of the connections of this generating unit to provide for the necessary difference in speed of the waterwheels and generator is shown in Fig. 2. The waterwheels are placed parallel instead of in line, and the generator is slightly above them. Shaft extensions were introduced to carry the chain drive.

Each of the two waterwheel shafts carries a 71-tooth sprocket wheel 45.49 in. diameter, while the generator shaft carries two corresponding 47-tooth sprockets, 30.31 in diameter. Each pair of sprockets carries four Morse silent driving chains 31.67 ft. long and 21 in. wide, weighing about 2800 lb. each. The pitch is 2 in. throughout. The sprockets are made in halves and bolted on the shafts, which are 129 in. c. to c. The speeds are 149 r.p.m. for the waterwheel shafts and 225 r.p.m. for the generator shaft.

The chains have been tested to a strain of 40,000 lb. per sq.in., but the maximum tensile strain under ordinary

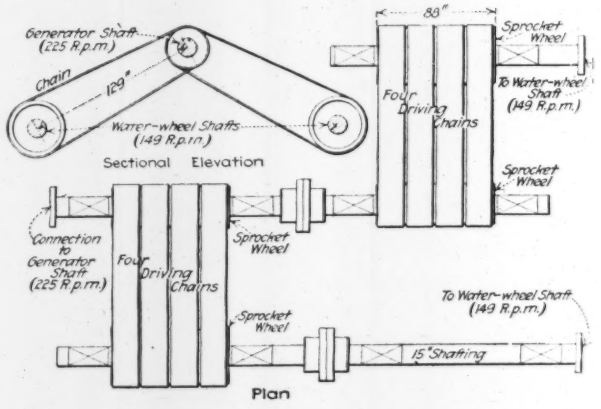


FIG. 2. 5000-HP. CHAIN DRIVE FROM TWO WATER-WHEEL SHAFTS TO A SINGLE GENERATOR SHAFT: OX-BOW HYDRO-ELECTRIC PLANT

operating conditions will be 600 lb. per sq.in. It is stated that the largest chain drive previous to this was of 1500 hp., so that this 5000-hp. drive is by far the largest yet installed.

The designs were made in the office of the W. H. Rosecrans Engineering Co., of Chicago, and the installation was made under the direct supervision of Mr. Rosecrans.

John R. Allen, Professor of Mechanical Engineering at the University of Michigan, acted as consulting mechanical engineer.

The New Sewerage System of Cairo, Egypt

The ancient city of Cairo, Egypt, is situated on the delta of the Nile. Its site is so nearly level that it was difficult to lay out a system of sewerage for the city in the ordinary way, with gravity discharge. In laying out the new sewerage system for the city which has been recently put in operation, therefore, the city has been divided into small areas and the sewage from each of these areas, after flowing by gravity to a central sump is forced by compressed air through closed pipes leading to a main outfall sewer.

So far as we are aware, this is the most extensive installation of compressed air apparatus for the forcing of sewage from district collecting stations that has ever been made. It is of course not novel as the Shone compressed-air ejector for forcing sewage has long been used in England.

A brief description of the Cairo system was given by Dr. E. L. Corthell in a paper published in "Professional Memoirs," Corps of Engineers, for May-June, 1915, following his visit to Cairo while the works were under construction. From this and from additional information furnished to Mr. Corthell recently by C. Carkeet James, M. Inst. C. E., under whose direction the works were constructed, the following description has been prepared.

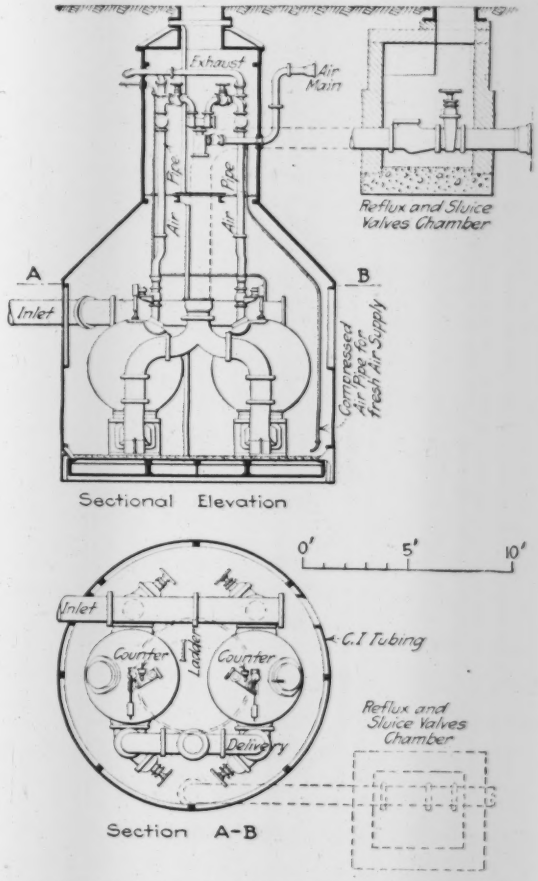
The total area in Cairo to be drained with the aid of compressed air is a strip 3 to 4 km. broad extending along the Nile for nearly 12 km. This tract has been divided into 63 small areas. In each of these the sewage flows by gravity to an underground compressed-air discharging station. From each of the stations the sewage is forced by compressed air through closed cast-iron pipes into a gravity outfall conduit, 1.6 m. in diameter, which starts at Pont Ghamra.

The accompanying drawing shows a section of a compressed-air discharging station. Each station contains two spherical cast-iron sewage receivers. The sewage from the district draining to the station flows into the receiver by gravity until the receiver is filled. A float in the receiver then opens a valve admitting compressed air and at the same time closes another valve, which shuts off the inflow of sewage. The compressed air forces the sewage contained in the receiver out through a discharge pipe leading from the bottom of the receiver. When the receiver is empty the compressed air is cut off and the inlet valve is again opened. The process is entirely automatic, and the apparatus is claimed to have been so designed as to require little supervision to keep it in working order.

The compressed air used to operate the sewage-discharging stations is furnished by a central station, where there are four air compressors driven by triple-expansion engines delivering air at a pressure of from 22 to 25 lb. per sq.in. To insure continuous service, the compressed-air mains from the central compressing station to the sewage-discharging stations are laid on the loop plan.

In the main outfall sewer the sewage flows by gravity to a pumping station at Kafr-el-Gamus, a distance of 13½ km., receiving the discharge from various suburban gravity sewerage systems on the way. At the pumping station the sewage is screened and then forced by plunger pumping engines through a cast-iron delivery main, 0.92 m. diameter, to a sewage farm at Gebel-el-Asfar, a further distance of 11½ km.

The sewage farm (on which the sewage will be used for irrigation) is a tract in the desert about 4 km. square. The sewage delivered from the force main will pass through sedimentation tanks, and a portion of it may be further purified on gravel filter beds. It is expected that about 3000 feddans of land (3300 acres) will eventually be irrigated by sewage. About 350 feddans have been graded to receive irrigation water, and 170 feddans have been planted with 35,000 fruit trees, while 80 feddans of cereals are under cultivation. About 80 km. of compressed-air mains and sewage force mains from the compressed-air stations have been laid. Only a small part of the gravity sewers discharging to the compressed-air stations, however, has as yet been constructed. The area around the principal hotels and that near the military barracks, as well as some of the important suburbs, have been sewered. Further work on the laying of sewers was interrupted by the outbreak of war. The expenditure on the works thus far completed under Mr. James' direction is about £1,500,000 Egyptian. Approximately £500,000 Egyptian more will be required for laying the small sewers to the compressed-air discharge stations. The system has been planned for the needs of a population of about 1,000,000.



SECTIONAL VIEWS OF COMPRESSED-AIR DISCHARGE STATION, CAIRO SEWERAGE SYSTEM

Flood Wrecks Masonry Bridges*

In a heavy rain on July 28 in the northern part of Chautauqua County, New York, a number of bridges and culverts were washed out. Particular interest attaches to the failure of three masonry bridges of different types.

The Mason bridge at Dewittville on State Road No. 5263A was a 24-ft. span consisting of a 20-in. slab of gravel concrete, reinforced with ⅞-in. bars spaced 4⅝ in. c. to c. and ½-in. bars spaced 12 in. c. to c. across the road. It was built in 1912. Failure was due to undermining of both abutments, the water washing out the bed of the stream from a normal depth of about 18 in. to a depth of 12 ft. The roller seen standing on the bridge in the view belonged to the Ontario Roads Co., contractors for the state road at this place. It happened to be standing on the bridge at the time for the purpose of blocking the road, which was closed on account of other construction work. The high-water mark was about 18 in.

REINFORCED-CONCRETE SLAB BRIDGE WRECKED BY ABUTMENT UNDERMINING

over the roadway. The flood carried away about 600 cu.yd. of earthwork and the total damage is estimated at $2500.

The second bridge to fail was the Lefingwell bridge, an 8-ft. stone-arch culvert under the Buffalo-Erie highway. This was a structure of long standing. Practically all of the culvert was carried away, only a small length of the barrel remaining. How this stood up while the earth and masonry from above were carried through it is hard to explain. About 1000 cu.yd. of earth was taken away with the bridge. The total damage is estimated at about $2000.

The southeast wing wall of the Glenn Mill bridge, a 30-ft.-span concrete arch near Westfield was overturned, allowing the stream to carry away about 1500 cu.yd. of earth from the uncompleted fill. This failure was illustrated in *Engineering News*, Aug. 19, 1915, p. 379. The wing was previously cracked and the high water softened the toe of the slope, allowing the earth back of the wall to push it over. High-water marks indicated that the water reached a depth of about 10 ft. above normal. During the dry season of the previous year, while the bridge was under construction, all the water was carried through a 12-in. pipe. The damage is estimated at $2500.

In accordance with New York State Highway Law bridges of over 5-ft. span are town charges whether located on state and county highways or not, and steps have already been taken by the town officials for the replacement or repair of all these bridges.

*Information furnished by W. M. Acheson, Division Engineer, New York State Commission of Highways, Buffalo, N. Y.

State Supervision of Public Water-Supplies in Kansas

By Fred R. Hesser*

An effective plan for state supervision of water-supplies has been used for the past two years by the Kansas State Board of Health. Some of its details may be of interest to others connected with public-health work.

The water and sewage law passed in 1907 provides for the appointment of an engineer for the State Board of Health from the faculty of the Engineering School of the State University. The head of the Sanitary Engineering Department has always held this appointment as head of the Water and Sewage Division of the State Board of Health. The work of this division has increased in volume till at the present time two assistant engineers and a stenographer-clerk are employed. A laboratory is also maintained by this division at the University. It employs a force consisting of the director, chemist, bacteriologist, three laboratory assistants and two stenographers.

The provisions of the water and sewage law are as follows:

> That no person, company, corporation, institution or municipality shall supply water for domestic purposes to the public within the state from or by means of any water-works without a written permit from the State Board of Health for the supplying of such water. The application for such permit shall be accompanied by a certified copy of the maps, plans and specifications for the construction of such water-works or extension, and of a description of the source from which it is proposed to derive the supply and of the manner of storage, purification or treatment proposed for the supply previous to its delivery to consumers, together with such other data and information as may be required by the State Board of Health; and no other or additional source of supply shall subsequently be used, nor any change in the method of treatment be made without an additional permit. The supplying of water without a permit shall be deemed a misdemeanor, punishable by a fine of not less than $25 nor more than $50 for each offense. Each day shall constitute a separate offense.

The board is empowered to make any investigations of water-supplies upon complaint of municipal or public-health officers or to act upon its own motion, and to order such changes in the source of supply or method of treatment as may be necessary to safeguard the public health. Permission to discharge sewage into streams or other bodies of water must also be obtained from the board under practically the same conditions as to treatment as those described. The engineer and secretary of the board are empowered to act when the board is not in session.

The consulting engineers practicing in the state have come to realize that the provisions of this law do not work a hardship upon them but, on the contrary, serve to maintain a standard under which competition is more nearly fair and open. Consequently they are, with few exceptions, glad to coöperate with the engineers for the board in their requirements. Upon being advised that a town or corporation contemplates the construction of a water-works or a change in an old system, one of our engineers visits the town and makes a thorough inspec-

*Assistant Engineer, Kansas State Board of Health, Lawrence, Kan.

tion of the plant and discusses conditions with those in charge and with the engineers for the work.

The plans and information, when completed, are sent to the office of this division at Lawrence and must include the following items: General plans, detail plans, engineer's report, specifications, application. These are examined not only from the viewpoint of quality of supply but also that of adequacy for future growth, fire protection and mechanical efficiency. If necessary they are returned with a request that corrections be made and when satisfactory the blueprints are stamped "Approved" and signed by the engineer for the board. One copy of the plans is filed in the office of the secretary at the State House in Topeka and another in the engineer's office at the University. Arrangements have just been made to furnish blank progress-report cards to engineers in charge of such work. These will be returned to the office each month.

There are 197 plants in the state supplying water to municipalities. Of these, 16 are privately owned, 27 use surface water and rapid sand filters and 14 use surface water with no further treatment than coagulation and sedimentation.

Analyses of samples from each supply have been made at frequent intervals during the past three years, the surface water-supplies being watched very carefully. When sufficient evidence of poor quality of any water has been collected the city authorities or owners of the plant are approached and the improvement can usually be brought about without recourse to a formal order from the board. Occasionally, however, it has been necessary for the board to order improvements recommended by its engineer. Within the past year seven modern rapid sand filter plants have been installed by this method, and work is in progress on four more.

Acceptance of purification plants by the city or owner is made contingent upon approval by the State Board of Health. When ready for operation an engineer from this division, usually accompanied by the laboratory director, takes charge of the plant and operates it for two or more days. Alkalinity and turbidity determinations are made on the raw, coagulated, and filtered water at frequent intervals and bacteriological samples are plated on agar at hourly intervals. Bacteriological samples are also collected at two- or four-hour intervals and expressed to the laboratory in refrigerating shipping containers for check counts and B. coli fermentations. The test also includes calibration of orifice boxes, rate regulators and loss-of-head gages, quantity of wash water used and rate of application of wash water and air, clarifying effect obtained in the basins by the use of varying chemical doses applied at various points. The bacteriological standard heretofore required has been "a removal of 98% when the raw water count exceeds 3500 per c.c. or a count of less than 100 per c.c. in filtered water when the raw-water count is less than 3500 c.c., with complete removal of turbidity." The operators of these plants are instructed in making alkalinity titrations with erythrosene and turbidity readings with a candle turbidimeter. Compact kits containing the required apparatus and reagents are furnished at cost by the laboratory. The operators are also furnished a pad of blank-form operating reports. A duplicate copy of each is sent to the engineer's office each month. Since these plants are rarely large enough to employ a chemist this method enables us to check their operation. Usually the plant purchases a shipping container and weekly bacterial examinations of their samples are made free.

The refrigerating containers are manufactured in Lawrence for the laboratory of this division.[1] They consist of an insulated outer case and tightly fitting top from which is hung a copper box with divisions for 4 or 6 bacteriological sample bottles. Cracked ice is placed in the bottom and low temperature held for 48 hours.

Rules recently adopted by the Board provide for annual inspections of all water-works and sewage-disposal plants in the state by the engineers of this division. Standard information blanks will be used for recording the results of these inspections. Mineral, sanitary chemical, and bacteriological examinations of all ground water-supplies will be made twice each year and surface water-supplies will be examined bacteriologically, chemically, and microscopically each week. Each plant is charged a fee, graduated, according to the population supplied, from $12.50 to $150 per year. These fees are used to maintain the laboratory.

Sources from which common carriers supply drinking water are to be inspected and sampled twice a year. Springs, wells and other sources from which water is bottled and sold for domestic or public use will also be under the direct supervision of the State Board of Health.

Sulphur Causes Garbage-Reduction Odors

Study of the cause and prevention of odors and dust from garbage-reduction works in New York City has been made by the Central Testing Laboratory of the City of New York and a detailed report is given in the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society, September, 1915. At the plant studied the garbage arrives at the docks in open scows and is conveyed to large lined iron tanks or digesters. These are vented and the gases have considerable odor. The cooked garbage and liquor are run into vented receiving tanks before being pressed. Liquids are run to open settling tanks where the grease is skimmed off and the liquor discarded. The pressed garbage goes to direct-heat driers which give off odor and dust perceptible for miles around. The dried garbage is conveyed to a naphtha-extraction plant, and the tankage is dried in a second set of direct-heat driers with more odor and dust.

The odors from handling raw garbage, from the grease-separating tanks, from pressing and from conveying garbage under treatment are of only local importance. None of the substances (principally mineral matter and fats) carried over mechanically with the digester vent gases were found important. The condensable volatiles included essential oils and sulphur compounds. The extremely nauseating odor of uncondensable vent gases was found due largely to sulphur compounds. Simple heating of vent gases was useless, but washing with a solution of calcium hypochlorite prevented odors.

The scrubber installed removed 91% of the total dust from drier gases and 70% of the odorous substances. Leading the gas across pine-tar oil substituted the odor of the latter for the objectionable smell. No reasonable amount of a dilution with air was effective.

[1] See illustrated description, "Engineering News," Oct. 23, 1913, p. 819.—Editor.

Engineering Literature

Faults of Technical Literature

By R. Fleming*

Technical literature may be divided into two classes: That which finds its way to the public through periodicals, and that which appears in book form. This article has in mind the latter class, though much of what is written will apply to both divisions.

A glance through the catalogs of publishers of technical books will show what a bewildering number has been written on certain subjects. New books on Applied Mechanics are continually being brought out. Three books on Foundations closely followed each other in 1914. Books on Structural Engineering are being multiplied. Are all these books needed? A university lecturer in an article[1] entitled "Books for Engineers—A Criticism," in the Engineering Supplement of the London *Times*, of Jan. 31, 1912, writes thus of a search he had made:

> Two or three impressions were gained by this search. One was that a flood of technical books is emanating from America. . . . To come to the faults of the technical books which are now appearing so rapidly, many of them are badly written, badly arranged and badly priced. . . . Many authors do not appear to have in mind any definite purpose for their books. They do not seem to take the trouble to ascertain if such a book is really needed. They do not ascertain before beginning their task how far the field is really covered.

Books describing industrial processes are hardly out of the hands of the printer before the processes have been modified and new books are needed. But about those on Mechanics dealing with unchanging principles it is well to ask whether the new are better than the old. Of course, the best book on any subject is yet to be written. Not every writer has the confidence expressed in the preface of a textbook on Applied Mechanics: "The author claims that the chapters on Moment of Inertia, Center of Gravity, Work and Energy, Friction and Impact are more complete in theory and application than those of any other American textbook."

Most technical books are written by teachers in technical schools and colleges. There are several reasons for this. The teacher has access to libraries, is able or should be able to express himself clearly, and from his teaching experience knows the difficulties in grasping new subjects. Moreover, he has time at his disposal to which the professional man is a stranger. The college year seldom lasts over forty weeks and recitations and lectures are confined to comparatively few hours per week. Knowing that he may be rated according to the number of books he has written, he embodies his notes and lectures in a book, thus adding another to a field that may be well covered. The responsibility for overproduction rests largely upon the boards of trustees of our various institutions of learning, who in choosing a faculty generally put more stress upon authorship than upon teaching ability.

One cause of lack of accuracy is the acceptance without discrimination of what has already been written. An erroneous statement once fairly started has a surprising tenacity of life. Hutton's formula for wind pressure on inclined surfaces, although discredited, is constantly met with in textbooks, and handbooks. The Carnegie "Pocket Companion," edition of 1913, gives it, the Cambria Steel Co.'s Handbook, 1914, quotes it without a name attached, and the Handbook of the Lackawanna Steel Co., 1915, quotes it as Unwin's formula. Dates are often given wrongly, especially in footnotes. Euler's column formula is found dated both 1757 and 1759. In this case there is an explanation. The paper "Sur la Force des Colonnes, Par M. Euler" appeared in the "Histoire de l'Academie Royale" for the year 1757 but the volume bears the imprint, Berlin, 1759.

First editions are often lessened in value because of the number of errors resulting either from careless preparation of the manuscript or careless proofreading. One book before the writer has twenty-seven errors in twenty-two consecutive pages. Some are trifling but others are serious. A student has the help of his instructor in detecting errors, the "constant reader" will probably find them from the context, but the busy man who regards his library as his dictionary is liable to be led astray. The engineer who passes a problem with a given book to an assistant may receive an absurd answer or none.

From a large number of errors which have caused annoyance, three will be cited from books of recognized merit:

1. The "American Civil Engineers' Pocket Book," second edition, page 297, gives as the formula for bending moment of a cantilever beam uniformly loaded, $M = \frac{Wx^2}{2}\left(\frac{3}{4} - \frac{x}{l}\right)$. This should be $\frac{Wlx}{2}\left(\frac{3}{4} - \frac{x}{l}\right)$.

2. Johnson, Bryan and Turneaure in their analytical treatment of wind loading in "Modern Framed Structures," eighth edition, page 512, write: "and substitute the values of M and S_2 in (11b)." In this edition equation (11b) is not given and it is necessary to consult earlier editions.

3. Ketchum in "Steel Mill Buildings," third edition, page 119, in the figure of a double portal, gives a stress of 4242 lb. in the member c — 7 and the same in member c — 8. In each case it should be 2121 lb. The stress diagram is correctly drawn but the reader does not stop to scale a diagram. He looks at the stresses given on the figure. From this figure he would infer that for a double portal the stresses in certain members are equal to the stresses in certain other members when they are but one-half as much.

Lack of clearness occurs when an author leaves too much to be understood by the reader. In one standard treatise on Mechanics the reader must at times determine from his previous knowledge of the subject the meaning of + and —. A single sentence would clarify the whole matter. Another book that has passed through several editions contains an article of five pages on "The Flexure of Long

*American Bridge Co., 30 Church St., New York City.

[1]Reprinted in part in "Engineering News," of April 18, 1912.

columns." Near the close of the section is a paragraph commencing: "Euler's formula, therefore, is strictly applicable only to . . . ". While the student may infer that the formula deduced is the well-known Euler formula, it is not so expressed and the paragraph does scant justice to Euler.

Flexure in beams is almost invariably treated without any mention that the beam is considered as stayed laterally. One textbook, "Stresses in Structures," in showing how to use the tables in the rolling-mill handbooks quotes the full tabular load as the strength of a 9-in. beam with span of 20 ft. No mention is made of the proviso so explicitly stated in the handbook that the tabular loads apply only to beams stayed sideways. A note like the following, used in another book, would have left no room for doubt: "Due attention in selecting the beam must be given to lateral and vertical deflection as previously noted, or to a proper reduction of the specified fiber stress to allow for these reductions." In this connection it is noted that reports of beam tests lose their value when they do not state how the beam is stayed sideways.

It is conducive to clearness to find in all the pages of a book the same symbol denoting the same thing. Greene's "Structural Mechanics" is an illustration. In the introduction the author says: "The notation is practically uniform throughout the book and is that used by several standard authors." It is also a great help to find an introductory page or an appendix tabulating in alphabetical order all the symbols used. A few books give this. May their number be increased! A step farther would be a more general agreement among authors to use the same notation.

Plagiarism is an ugly word to use and happily the fault is not common. Yet occasionally when two books are compared it may be inferred that one copied from the other or that both borrowed from a common source. Some again quote a great deal and give credit for little. More prevalent still is the use of the work of thinkers and scholars without any mention of their names. Goodman's "Mechanics Applied to Engineering" is a model in the giving of credit. Instances are: Young's Modulus of Elasticity, Bow's Notation, Barlow's Theory, "the method is due to Professor Dalby," "the author and Mr. R. H. Thorpe of New York." Molitor is also to be commended. In the preface of his "Kinetic Theory of Engineering Structures" he states: "Each subject is prefaced by a few brief historical remarks and all important theorems bear the name of their originators, a practice which has been shamefully neglected by many modern writers." This is quite in contrast to the practice of some others to whom the lines of Kipling might apply:

When 'Omer smote 'is bloomin' lyre,
He'd 'eard men sing by land an' sea;
An' what he thought 'e might require,
'E went an' took—the same as me!

The market-girls an' fishermen,
The shepherds an' the sailors, too,
They 'eard old songs turn up again,
But kep' it quiet—same as you!

They knew 'e stole; 'e knew they knowed.
They didn't tell, nor make a fuss,
But winked at 'Omer down the road,
An' 'e winked back—the same as us!

In closing let it be said that despite its faults technical literature was never better than it is today.

Transition or Spiral Curves

REVIEWED BY HENRY J. SAUNDERS*

THE RAILROAD TAPER: The Theory and Application of a Compound Transition Curve Based upon Thirty-Foot Chords—By Lew Perkins, Formerly Assistant Engineer Southern Pacific Lines in Arizona and Mexico. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Flexible leather; 4x7 in.; pp. x + 356; 41 text illustrations; 42 tables. $2.50, net.

In the "Railroad Taper," Mr. Perkins has presented the subject of transition or spiral curves as developed by William Hood, chief engineer of the Southern Pacific Co. The curve used is a series of compound curves developed from a basic chord length of 30 ft. A set of tables is also given based on the 10-meter chord for use in Mexico and South America.

Mr. Perkins' work as a whole, although it cannot be said to be the last word in spiral curves, still seems to be such an improvement over other books and tables on the subject that it deserves little criticism and much praise. The writer has taken the trouble to compare this work with some ten or more others on the same subject and can say that with one or two exceptions this is the only work which can be used easily and universally by the man in the field under nearly all conditions.

The writer believes that a better understood title for the book should have been selected or at least that the word "curve" should have immediately followed the word "taper." Of some ten books examined no one of them used the word taper, three using "spiral," four "transition curve," two "transition spiral" and one "parabolic curve." Webster defines the noun "taper" as "a gradual diminution of thickness in an elongated object," referring more to volume than to surface.

The writer believes that Mr. Hood had some well-defined reason for the selection of the 30-ft. basic chord length and believes that should be brought out in this work, owing to the fact that a great many engineers look with disfavor on any unit of measurement which will not go into 100 an even number of times.

The location and track problems selected are good and cover the usual run of problems encountered in the field. The tables are ample, although the writer believes that a more definite nomenclature should be selected for the different types of taper in order that the necessary table could be selected at a glance without having to study out the system of numbering.

The author explains fully the relation of the speed of the train to the length and number of the taper selected. This is a point which cannot be too fully impressed upon the field engineer.

The slight changes which have been suggested would make the book of general value to engineers, although as it stands it can certainly be used as well or better than any other work on this subject.

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A summary of the operating results of the water-softening and filtration plant of McKeesport, Penn., occupies a large part of the annual report for 1914 of the water and lighting commissioners of that city. A folding table giving data by months and by yearly averages for six years is included. There is also a description of the plant. The summary was written by Edward C. Trax, chemical engineer, who is in charge of the filtration plant.

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The Theory of Direct-Acting Steam Pumps

REVIEWED BY H. E. LONGWELL*

DIRECT-ACTING STEAM PUMPS—By Frank F. Nickel, Associate in Mechanical Engineering, Columbia University. New York and London: McGraw-Hill Book Co., Inc. Cloth, 6x9 in.; pp. x + 258; 218 illustrations. $3, net.

The author has set himself a rather thankless task, for the reason that his subject is one that has ceased to be of much general interest from an engineering standpoint. He has developed a somewhat elaborate theoretical treatment of the direct-acting steam pump, which it is hardly probable ever existed in the minds of the pioneer designers of this type of machine, whose lead apparently has been blindly followed by their successors.

Table 17 (page 181), giving a list of standard sizes of boiler feed pumps, furnishes sufficiently convincing evidence that to a large extent designs for this type of pumps have been based on "rule-of-thumb" methods rather than on exact calculations. If the design were based on logical principles it is evident that the ratio of diameter of water cylinder to steam cylinder should be fairly uniform throughout the list. If, as the author states, the mechanical efficiency increases materially with the length of the stroke, it is obvious that any departure from uniformity should be in the line of an increasing ratio in the larger sizes.

If a 4-in. water cylinder is correct for a 6-in. steam cylinder with 6-in. stroke and 65 per cent. mechanical efficiency, there can hardly be any good reason for making a water cylinder so small as 5¼ in. in connection with a 9-in. steam cylinder of a 10-in. stroke pump, having an alleged mechanical efficiency of 75 per cent., or a water cylinder only 7 in. diameter for a 12-in. steam cylinder of a 12-in. stroke pump of 77.5 per cent. mechanical efficiency.

Inasmuch as substantially the same list has been "standard" for over thirty years, it is apparent that the matter of proportions of water cylinder to steam cylinder has never been given any serious engineering consideration. Furthermore, there is no evidence that the proportions of any of the so-called "standard" sizes are really logical.

The book opens with a short chapter on the development of the direct-acting steam pump. This is followed by a chapter on performance factors, which is largely theoretical and applies to any type of reciprocating pump.

Chapter III (about 100 pages) is entitled "Classification and Types." It undertakes to explain the numerous ingenious designs of single-cylinder steam ends that were devised to evade detail patents rather than because they possessed any marked inherent merits either practical or theoretical. The descriptions are too meager and the illustrations too incomplete to make the matter clear to a novice. For example, Fig. 28 (page 45) shows a piston in a position where it shuts off the steam port completely, and the means for getting steam into the cylinder to propel the piston is left to the imagination of the reader. The operation of the valve gear of duplex pumps is explained at length, and considerable space is devoted to a discussion of various designs of water cylinders.

The action of the cross-exhaust which makes the expansive use of steam possible in a direct-acting compound pump without compensating devices is described in a clear and interesting manner, and practical formulas are evolved for calculating the cylinder ratios of such pumps. There are also a number of elaborate tables of doubtful value, which purport to give the mean effective pressure referred to the high-pressure cylinder, and the steam force in pounds in multiple-expansion pumps of many sizes working under various boiler pressures, both condensing and noncondensing.

Two chapters are devoted to the mechanical design of water and steam ends, giving formulas—more or less empirical—for the strength and proportion of parts.

Chapter VI discusses sundry types of pumps from the standpoint of their suitability for different kinds of service. Chapter VII deals with the economic performance, or "duty" of pumps. It includes seven pages of tables, which claim to give the actual duty in millions of foot-pounds per 1000 lb. of steam over the whole range of sizes, from the tiny simple pump of 4-in. stroke working with 50-lb. boiler pressure to a triple-expansion condensing pump of 48-in. stroke working under a boiler pressure of 200 lb. Except in the case of a large water-works pump, carefully designed to meet conditions that can be predicted with accuracy, the duty of a direct-acting steam pump is pretty much of a joke, and this chapter should not be taken too seriously. Engineering literature is singularly free from reports of actual tests of ordinary direct-acting pumps, and the author does not undertake to supply this deficiency. The duties given in the tables are most probably calculated, and no evidence is offered to the effect that they are in close agreement with the results of actual experiment.

The book closes with a very brief chapter on the operation and adjustment of direct-acting pumps and with an appendix consisting of tables giving the frictional resistance of Pennsylvania and California oils in pipe lines of sundry lengths and diameters at various rates of flow.

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Essays on Promoting Efficiency

EXPERIENCES IN EFFICIENCY—By Benj. A. Franklin. [Works Management Library.] New York: The Engineering Magazine Co. Cloth; 5x8 in.; pp. xi + 167. $1.

HINTS CONCERNING THE ORGANIZATION OF WORKSHOPS AND FACTORIES—By Robert Grimshaw, Consulting Engineer; Lecturer, New York University School of Commerce, Accounts and Finance, Pratt Institute, etc.; author of "Catechisms of Locomotive and Stationary Steam Engines, Boilers and Pumps"; "Shop Kinks"; "Workshop Practice"; "Werkstatt Betrieb und Organization"; "System und Organization in kaufmaennischen Betrieben," and other practical works in English, French and German. New York: New York University Book Store, University Building, 32 Waverly Place. 4x6 in.; pp. 104. 50c.

Mr. Franklin's little book contains some articles, reprinted from *Engineering Magazine,* relating in conversational style a few cases of decreasing manufacturing costs and increasing workmen's rewards for labor. The author's particular contribution to the field seems to be a quality-piece-work scheme of payment for labor, by which the total wage secured depends both on quantity of output and reduction of waste. Some experience is cited with "gang piece-work" pay. Where a number of men were involved in a multitude of operations, the cost of the finished product was determined and used as the basis of a gang payment, which was divided among the various workmen in some proportion judged to be fair. The result was greater coöperation, increased and cheapened output, improved quality and larger wages per man.

Applying efficiency methods to the efficiency men themselves is an unusual theme taken up. The statistical clerks were induced to record the times of their own operations and this furnished the handle for scheduling progress of shop records. The men saw chances of improving their own work, and seven took on extra tasks that before would have required two more men.

There are also some interesting comments on building up a real cost-accounting system. Throughout the author displays a sensible moderation in scrapping old methods which may give good results—straight piece-work wages in some plants, for instance.

The Grimshaw pamphlet appears to be a condensation of lectures given at the New York University and the Pratt Institute. The text consists of tabular or skeleton arrangements of abbreviated expressions defining the aims and methods of organized business, the functions of manufacturing plants and productive departments. Handling stock and labor, reducing costs, increasing production, etc., are similarly taken up "in breathless style."

Descriptive Geometry for Draftsmen

REVIEWED BY ALTON L. SMITH*

THE ESSENTIALS OF DESCRIPTIVE GEOMETRY—By F. G. Higbee, M. E., Professor and Head of Department of Descriptive Geometry and Drawing, State University of Iowa. New York and London: John Wiley & Sons. Cloth; 6x9 in.; pp. vi. + 204. $1.80, net.

The author aims to present the subject from the viewpoint of the draftsman. The first fifth of the text explains the general principles of projection and discusses the elementary operations employed in the solution of space problems. The next fifth takes up 17 simple propositions relating to the point, line and plane, the statement in each case being followed by a discussion of the space solution and explanation of the geometric constructions used. The remainder of the book is devoted to the subject of surfaces. Each chapter is followed by a set of practice problems, the whole totaling nearly 300. One entire chapter deals with making paper models of sheet-metal work. The book concludes with an appendix giving useful geometric constructions.

To help the student visualize and vitalize his problem, the author makes use of solids instead of dealing with the geometric point, line and plane. Thus, finding the actual length of a line when its projections are given is presented as a problem of finding the overall length of the inclined brace of a wooden bracket. This method is supposed to overcome two difficulties. First, it is thought that a student can imagine a block of wood much easier than he can conceive of a wire or sheet of cardboard. Second, it is believed that the student can more quickly apply his principles to engineering problems if he has worked out his elementary problems in magnitudes of commercial shape and dimensions instead of the usual ones employed by the mathematician. The problems presented cover a fair range and in most cases have a "practical flavor" rather than real commercial application.

The large amount of space given to sheet-metal pattern work and the total exclusion of some other useful topics will impair the value of the book for those who desire the treatment to be comprehensive, even though brief. However, the matter on surfaces probably constitutes the most valuable feature of the book.

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Fundamentals of Hydraulics

ELEMENTS OF HYDRAULICS—By S. E. Slocum, Professor of Applied Mathematics in the University of Cincinnati. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xi+294; 210 illustrations. $2.50, net.

Professor Slocum evidently has aimed to instruct the student in the fundamentals of hydraulics and simultaneously to impress him on certain important practical applications of theory which should be well known. The book is another evidence of the tendency to break away from academic presentations of pure theory to secure the interest of the student and to visualize the abstractions which once were all too exclusively dealt with.

The book starts off with a brief review of the old academic "hydrostatics"—properties of water, pressure phenomena, properties of floating bodies, etc.—but into this is injected a consideration of presses, accumulators, jacks, elevators, dams, locks, barges, etc. This is done partly by inserted discussions and partly by a group of real and hypothetical engineering problems. The Kensico dam and Keokuk lock are among the actual structures considered.

The convenient term "hydrokinetics" appears here, as in the more academic treatises; but the treatment follows the lines indicated for the preceding section. "Hydrodynamics" is a term also retained to make the subject of hydraulic machinery sound formidable. The division of the book among these parts is 17, 40, and 43 per cent.

In taking up hydrokinetics the formula for flow out of crifices, over weirs and through pipes and nozzles is developed. The author introduces early the idea of stream lines and liquid veins to facilitate the later discussions of kinetic pressure and stream gaging. Venturi meters and siphon spillways are also treated.

Flow in open channels follows, the Kutter, Bazin and Chezy formulas being briefly presented as experimental deductions. Stream gaging by current meters is mentioned, and the use of pitot tubes is discussed at some length. Six pages are devoted to backwater curves in channels—not too much space considering the immediate importance of backwater from stream obstructions. Waterworks problems figure in the appendix to hydrokinetics.

Hydrodynamics is attacked by studying impact on varicus stationary and moving surfaces, as an introduction to impulse wheels. The reaction of jets serves to open up the subject of reaction turbines. Both classes of machines are presented in their practical details as well as in their underlying theories.

One of the most interesting and useful parts of the book is the review of design characteristics as developed in this country by Zowski and Baashuus (*Engineering News* of Jan. 28, 1909, and Mar. 2, 1911). Of course this is not gone into far enough so that designing can proceed with this text as a guide, but enough is given to be of great aid in understanding the proper selection of wheels. The scope of the section on centrifugal pumps may be similarly described.

Not all the minor matters have been here noted—such as water hammer and displacement pumps; their treatment is in keeping with their importance compared with the other sections noted herein.

Linear Perspective

REVIEWED BY CHARLES W. REINHARDT*

THE PRINCIPLES AND PRACTICE OF LINEAR PERSPECTIVE, Developed Along Original Lines: Being a Practical Handbook for Architects, Civil and Mechanical Engineers, Art Designers, Engravers, and for Draftsmen Engaged in All the Industrial Arts, Including a Self-Explanatory Linear Perspective Chart in Simplified Form—By Herman T. C. Kraus, C. E. Second Edition, Revised and Enlarged. New York: Norman W. Henley Publishing Co., 132 Nassau St. Cloth; 10x13 in.; pp. 53; 15 plates of practical examples. $2.50.

The present edition of this book does not seem to differ from the first edition, except for the addition of a "Self-Explanatory Linear Perspective Chart." This chart is said to be the "only complete nontechnical one ever issued," and it is also stated that "by its careful study the student and layman can obtain a complete knowledge of perspective." The least that could be said about this chart is that it would have gained greatly in appearance if reduced to about one-half size.

The fifteen plates of practical examples accompanying the text are all made by the "wax-process," and while appearing clean-cut and well executed, exhibit a questionable system of outline shading (see Figs. 1, 2, 6, 7 on Plate I, Fig. 6 on Plate XI and similar ones). The subjects represented seem, however, to be well chosen; the text likewise is lucidly written and directly applied. Paper and printing are excellent, as well as the binding.

THE A B C OF IRON AND STEEL, With a Directory of the Iron and Steel Works and Their Products of the United States and Canada—Edited by A. O. Backett. Cleveland, Ohio: The Penton Publishing Co. Cloth; 8x11 in.; pp. xv + 338; 222 illustrations. $5, postpaid.

An interesting and attractive treatise on American iron and steel making, written in a somewhat popular style, has here been secured with the coöperation of sixteen men well known in the industry. There are chapters on ore and mining, the preliminary treatment, or "beneficiation," of ores, valuation of ore, transportation and handling, beehive and byproduct oven coke, blast furnaces, puddling processes, crucible, bessemer and open-hearth steel, rolling and wire-drawing mills, malleable castings, steel foundries, and electric steel furnaces. Appended to this descriptive matter are numerous statistical tables relating to the American industry and a directory of concerns in this country and Canada making pig and wrought iron, steel and mill products.

In the notice of Dr. H. B. Hemingway's "Legal Principles of Public Health Administration" (*Engineering News* of July 15, p. 120), a word was accidentally omitted from the brief quotation from the book in the third paragraph of the review. We repeat the paragraph, giving the quotation correctly, with the omitted word in roman:

"In view of several flattering tributes paid by the author to the engineering profession, including a statement that it might be better to choose a health officer from sanitary engineers than from physicians, it may seem ungracious on our part to point out that in discussing sewage treatment he says that the Imhoff tank 'takes the crude sewage and pours out water much clearer than that found in many streams, and practically devoid of *harmful* bacteria.' This is clearly a misconception of the object and the effect of the Imhoff tank, but it may not do much harm in this book."

The omission of the word "harmful" misrepresents the author in a way which was wholly unintentional and is regretted. It did not affect the criticism, which was addressed to the correct and not to the incorrect quotation.

SHAPE BOOK, Containing Profiles, Tables and Data Appertaining to the Shapes, Plates, Bars, Rails and Track Accessories Manufactured by Carnegie Steel Company, Pittsburgh, Penn. Fifth Edition, 1915. Flexible leather; 5x8 in.; pp. 312; illustrated.

It is four years since the last previous edition of this book was issued, and the new volume just printed shows a remarkable development in many lines of special manufacture. It is now possible for the designing engineer to command a far greater variety of forms in standard rolled sections than existed only a few years ago. For many of these new sections the automobile industry is responsible. Another development has been in small sections used in the construction of metal window frames, skylights, etc. A variety of types of deformed bars for concrete reinforcement is shown. A considerable number of the sections have been rolled for special customers and are obtainable only by special arrangement. Their inclusion in the book is of value, however, as there would doubtless be no difficulty in obtaining these special sections by any engineer who desired to use them for purposes not competitive with the company for which the section was originally rolled.

HUMAN NATURE AND RAILROADS—By Ivy L. Lee. Philadelphia: E. S. Nash & Co. Cloth; 5x8 in.; pp. 129. $1, net.

The series of addresses which are printed in this book were delivered by Mr. Lee before various public bodies during the past year. Their general purport is to impress upon the public the need of a square deal in the treatment of the railways by the public and the public's representatives—the legislatures, commissions and courts. In an address entitled "Training the Railroad Man," delivered before the Society for the Promotion of Engineering Education, Mr. Lee deals with the problem of the best training for students in technical and other schools.

Especial interest attaches to this book because its author was the active agent in carrying out the policy of publicity adopted by the Pennsylvania Railroad a few years ago. In "Telling the Railroad Story," Mr. Lee explains how that policy has been carried out.

A three-plane (isometric projection) horsepower chart for gears and pulleys is published by the Mesta Machine Co., of Pittsburgh, as Bulletin Ka. Curves show pitch-circle velocity, pitch-circle load and horsepower for various revolutions per minute, torques and pitch diameters.

A handbook of India has been issued by the United States Department of Commerce, in an effort to stimulate interest in the Indian market on the part of American manufacturers. This is a book of 640 pages and deals with the resources, industries and commerce of India. It contains many illustrations, a large detailed map and facts concerning a multitude of Indian activities and conditions, with interesting accounts of the native states and of Ceylon, Afghanistan and Tibet. E. E. Pratt, chief of the bureau, states that this work is regarded as one of the most valuable publications ever produced by his

*Of Reinhardt-Winters-Cahill Co., technical illustrators, Times Building, New York City.

bureau. It is known as No. 72 in the series of special consular reports, and may be obtained for $1 from the Superintendent of Documents, Washington, D. C.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS—Proceedings of Annual Meeting Held at Rochester, N. Y., June 22-25, 1915. Chicago, Ill. (c/o M., St. P. & S. S. M. Ry.): P. W. Drew, Secretary Paper; 6x9 in; pp. 270.

A BIBLIOGRAPHY OF MUNICIPAL GOVERNMENT IN THE UNITED STATES—By William Bennett Munro, Professor of Municipal Government, Harvard University. Cambridge, Mass.: Harvard University Press. Cloth; 6x9 in.; pp. xiii + 472. $2.50, net.

THE BOOK OF WIRELESS: Being a Clear Description of Wireless Telegraph Sets and How to Make and Operate Them, Together with a Simple Explanation of How Wireless Works—By A. Frederick Collins, Author of "Wireless Telegraphy, Its History, Theory and Practice," "The Book of Stars," "The Book of Magic," etc. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. xv + 222; 219 illustrations. $1, net.

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COMPASS SURVEYING AND THE SIMPLIFIED CALCULATION OF FARM AREAS—By Charles Mitchell Thomas, Civil Engineer and Surveyor. Wytheville, Va.: The Author. Cloth; 6x8 in.; pp. vi + 92; charts. $2.

ELECTRIC WIRING SPECIFICATIONS—By J. H. Montgomery, Professor of Physics and Electrical Engineering, University of Southern California. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. 139. $1, net.

ELECTRICAL MEASUREMENTS AND METER TESTING: A Book in Plain English for the Student and Practical Man; Fundamental Theory, Practical Applications and Examples—By David Penn Moreton, Associate Professor of Electrical Engineering, Armour Institute of Technology. Chicago, Ill.: Frederick J. Drake & Co. Linen; 4x7 in.; pp. 328; 191 illustrations. $1.

HANDBOOK OF THERMODYNAMIC TABLES AND DIAGRAMS: A Selection of Tables and Diagrams from "Engineering Thermodynamics" by Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University —Arranged and Amplified by John J. Flather, Professor of Mechanical Engineering, University of Minnesota. Cloth; 6x9 in.; pp. xvi + 238; 82 charts. $1.50, net.

IDIOSYNCRASIES OF UNDERGROUND WATER—By Robert E. Horton, Consulting Hydraulic Engineer, 57 No. Pine Ave., Albany, N. Y. [Reprinted from Proceedings of the Connecticut Society of Civil Engineers for 1915.] Paper; 6x9 in.; pp. 56; illustrated.

INTERNAL COMBUSTION ENGINES, Theory and Design: A Textbook on Gas and Oil Engines for Engineers and Students in Engineering—By Robert L. Streeter, Assistant Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute. New York and London: McGraw-Hill Book Co., Inc. Cloth; 7x10 in.; pp. xi + 418; 240 text illustrations and drawings. $4, net.

AN INVESTIGATION OF IOWA FIRE CLAYS—By Milton F. Beecher. Bulletin 40, Engineering Experiment Station. Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 117; illustrated.

IRRIGATION AND SETTLEMENT IN AMERICA—By A. D. Lewis, Circle Engineer, Irrigation Department, Union of South Africa; late of the Public Works Department of Punjab, India. Pretoria, South Africa: Government Printing and Stationery Office. Cloth; 8x11 in.; pp. 258; illustrated. 10/6 post free.

IRRIGATION PRACTICE AND ENGINEERING: Vol. I, Use of Irrigation Water and Irrigation Practice—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 213; 77 illustrations. $2, net.

A MANUAL FOR HEALTH OFFICERS—By J. Scott MacNutt, Sometime Health Officer of Orange, N. J., and Member of the Board of Examiners of Health Officers and Sanitary Inspectors of New Jersey; Lecturer on Public Health Service in the Massachusetts Institute of Technology: With a Foreword by William T. Sedgwick, Professor of Biology and Public Health, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. x + 650: $3, net.

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THE MINERAL RESOURCES OF TEXAS—By William B. Phillips. Bulletin No. 365. Austin, Tex.: University of Texas. Paper; 6x9 in.; pp. 362; illustrated.

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OIL ENGINES FOR PUMP IRRIGATION AND THE COST OF PUMPING—By George E. P. Smith. Bulletin 74, Agricultural Experiment Station. Tucson, Ariz.: University of Arizona. Paper; 6x9 in.; pp. 72; illustrated.

PRACTICAL SURVEYING for Surveyors' Assistants, Vocational, and High Schools—By Ernest McCullough, M. Am. Soc. C. E., author of "Engineering Work in Towns and Cities"; "The Business of Contracting"; "Engineering as a Vocation." New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. ix + 42; 229 illustrations. $2, net.

PROPERTIES OF STEAM AND AMMONIA—By G. A. Goodenough, Professor of Thermodynamics, University of Illinois. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 7x10 in.; pp. vii + 108; illustrated. $1.25, net.

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THE SAMPLING AND CHEMICAL ANALYSIS OF IRON AND STEEL—By O. Bauer and E. Deiss of the Royal Testing Bureau at Gross-Lichterfelde, Germany. Authorized translation from the German by William T. Hall and Robert S. Williams, Massachusetts Institute of Technology. [International Chemical Series.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiv + 373; 173 illustrations. $3, net.

STANDARDS FOR RUBBER COVERED WIRES AND CABLES, Including Label Service Manual, "National Electrical Code" Specifications and Underwriters' Laboratories' Standards for Physical and Chemical Tests of Rubber Compounds Used for Electrical Insulation—Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago, Ill. Paper; 6x9 in.; pp. 126; illustrated.

STRUCTURAL STEEL: Handbook No. 16—Compiled and Published by R. A. Skelton & Co., Moorgate Station Chambers, London, E. C., England. Cloth; 7x9 in.; pp. 319; illustrated.

SURVEYING AND FIELD WORK: A Practical Textbook on Surveying, Leveling and Setting-Out, Intended for the Use of Students in Technical Schools and Colleges and as a Work of Reference for Surveyors, Engineers and Architects—By James Williamson, Assoc. M. Inst. C. E. [The Glasgow Textbooks.] New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xxii + 363; 271 illustrations. $3, net.

SURVEYING MANUAL: A Manual of Field and Office Methods for the Use of Students in Surveying—By William D. Pence, M. Am. Soc. C. E., Professor of Railway Engineering, University of Wisconsin, and Milo S. Ketchum, M. Am. Soc. C. E., Dean, College of Engineering and Professor of Civil Engineering, University of Colorado. Fourth Edition. New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. xiv + 388; illustrated. $2, net.

TESTS OF SUBMERGED ORIFICE HEADGATES FOR THE MEASUREMENT OF IRRIGATION WATER—By F. L. Bixby, Irrigation Engineer. Bulletin 97, Agricultural Experiment Station. State College, N. M.: New Mexico College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 55; illustrated.

A TEXTBOOK OF ENGINEERING THERMODYNAMICS—By Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University, and John J. Flather, Professor of Mechanical Engineering, University of Minnesota: An Abridgment of "Engineering Thermodynamics," by Charles Edward Lucke. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xxiv + 688; 189 illustrations. $5, net.

VALVES AND VALVE GEARS: Vol. II, Gasoline, Gas and Oil Engines—By Franklin DeRonde Furman, M. Am. Soc. M. E., Professor of Mechanism and Machine Design, Stevens Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 190; 216 illustrations. $2, net.

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No. 356: Surface Water Supply of the United States, 1913; Part VI, Missouri River Basin. Pp. 291.

No. 375-B: Ground Water in Paradise Valley, Arizona —By O. E. Meinzer and A. J. Ellis. Pp. 26.

No. 375-C: The Relation of Stream Gaging to the Science of Hydraulics—By C. H. Pierce and R. W. Davenport. Pp. 10.

No. 375-D: Ground Water in Big Smoky Valley, Nevada —By O. E. Meinzer. Pp. 31.

No. 375-E: A Method of Correcting River Discharge for a Changing Stage—By Benjamin E. Jones. Pp. 10.

Field and Office

Baby Mixer Proves Economical

Unusually efficient work was observed recently in concreting with a baby batch mixer. Rapid mixing and placing of concrete, great adaptability to conditions of ground, etc., and, to all appearances, very low cost were features of the performance. The case was the concreting of column footings for the Delco Building, a large reinforced-concrete structure now under erection at Dayton, Ohio.

The 93 footings of the building, 2 ft. to 14 ft. below ground floor and from 1 yd. to 7 yd. in contents of concrete, were ready for concreting long before the mixing plant and towers were assembled and erected. As the footing pits tended to cave, it was desired to concrete them as soon as excavated to save extra work in holding the walls or clearing the pits.

Work was begun by hand mixing, but this proved too expensive on account of rehandling sand and stone, as well as too slow—the excavation got too far ahead of the concrete.

Half-Bag Batch Mixer for Direct Depositing

A self-propelling half-bag mixer (Foote) was then brought on the job. It proved successful from the start.

The mixer was run under its own power to a point near enough to the footing so that the concrete could be chuted from the mixer to place. In many instances the gravel aggregate was taken direct from the excavation in which case only the cement had to be wheeled.

The full day's capacity of the mixer (said to be 80 cu.yd. in 10 hr.) was never used, but some very good short-time performances were made. The best was 7 yd. in 28 min., with a force consisting of one foreman, one operator, two shovelers, one material wheeler, one batch tender and one puddler. In this particular case the material was specially convenient and the mixer was placed more advantageously than usual. In numerous other cases, however, 45 yd. in 8 hr. was turned out, with two wheelers added to the gang.

Wheeling Concrete for Wall Work

For forming the walls (2 ft. to 10 ft. high) of the ground-floor sill and of the interior tunnel, a directly opposite method of using the portable mixer was employed—keeping the mixer stationary and wheeling the concrete from it to the wall. This was on account of the small yardage of concrete per foot of wall. Actually, it was found that wheeling concrete as far as 150 ft. was cheaper than moving the mixer, rehandling material and rebuilding runways.

The labor cost per yard of concrete was higher under this method than under that used for the footings because three more men were required in wheeling.

Factors of the Machine's Success

The fact that the mixer was self-propelled turned out to be very valuable. Often the machine crawled over piles of excavated dirt like a snail, but it always got there and it was mired only once.

The simplicity of the mechanism was another important element. A second-class engineer was hired and he operated it successfully. In turning out about 1000 yd. of concrete the mixer held work up only twice, and only one of these cases is chargeable to the machine.

More Use of Motor Trucks for Hauling Structural Steel

By D. P. N. Little*

I was very much interested in the article in *Engineering News* of July 22, 1915, by William Collins, Jr., describing the hauling of heavy girders for the Jerome Ave. elevated-railway structure in New York City. The article was of particular interest, for we have these hauling problems confronting us on the Pacific Coast, as well as our brothers in the East; and just at this time the Union Iron Works, of Los Angeles, had to consider the problem of

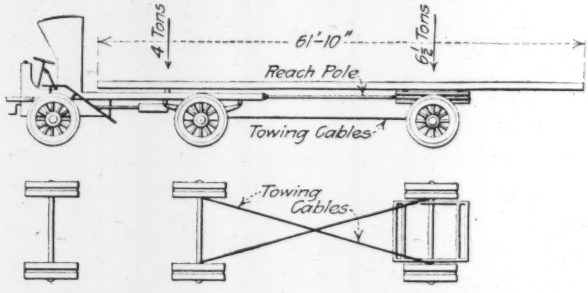


FIG. 1. SKETCH PLAN OF METHOD OF CONNECTING TRUCK AND TRAILER FOR HAULING STRUCTURAL STEEL

transporting two girders, 72 in. deep by 61 ft. 10 in. long, weighing about 11 tons each, which were designed for a bridge on Cypress Ave., between Los Angeles and Orange Counties, 24 mi. distant from the shops.

As the location was not convenient for shipping by rail, it was decided to use a 3½-ton motor truck with a two-wheeled rubber-tired trailer. The roads for most of the way are thoroughly improved, although there are quite a number of very short turns.

The accompanying sketch, Fig. 1, shows the method of loading, about 6½ tons being put on the trailer and about 4 tons on the truck.

The trailer frame has swivels at two points, and the tow-line connection of crossed wire cables from axle to axle compels the trailer to take the same circle as the rear wheels of the truck. The second swivel frame carries the reach pole, which is connected to the rear end of the truck body by a toggle joint, but it does not carry any strain. The upper swivel frame acts as a bolster and is provided with rollers. The girder was securely chained to the swivel frame of the trailer as well as to a swivel bolster on the body of the truck. Both girders were safely

*President of the Union Iron Works, Los Angeles, Calif.

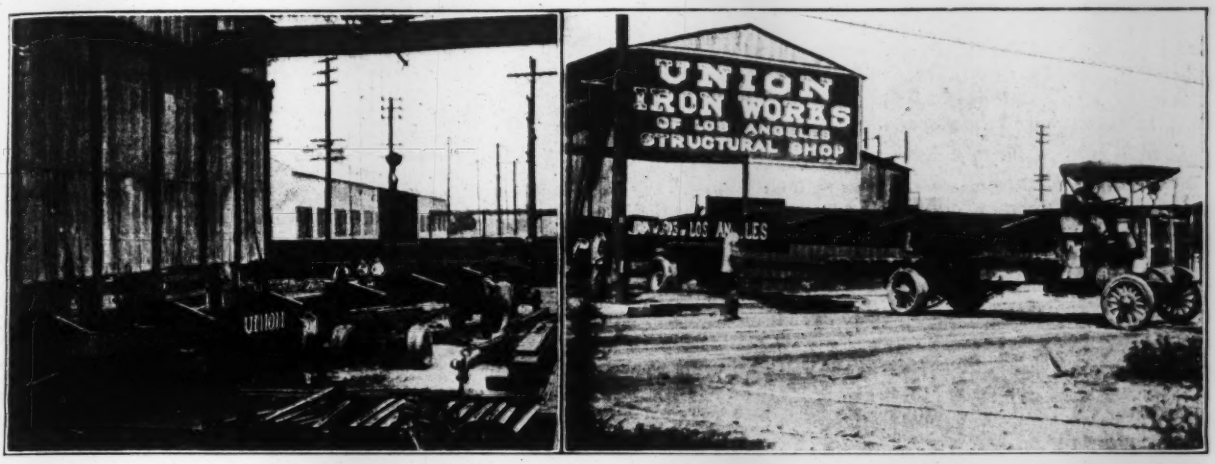


FIG. 2. LOADING AND HAULING 11-TON STEEL GIRDERS BY MOTOR TRUCK AND TRAILER

transported to their destination without incident, the time consumed from start to finish being 10 hr. for each girder. This would have been cut to 8 hr., but the weather was unusually warm and the oil-macadam roads were rather soft.

We have estimated (taking the period of the year as a basis) that the operation of our truck, including depreciation, labor, upkeep and fuel expenses, averages about $1 per hr. of operating time, and if this assumption is correct we transported these girders 24 mi. for a little less than $1 per ton. However, taking Mr. Collins' estimate of $20 per day it would make our hauling cost about $1.90 per ton, or 7.91c. per ton-mile as against Mr. Collins' 16½c.

With this same truck we have hauled steel beams 57 ft. long 66 mi. to Riverside without the use of a trailer. We find this cheaper than loading on two flat-cars.

Lifting Bridge Trusses to Adjust Rollers

By H. T. Welty*

The Ottawa & New York R.R. and the Ottawa Division of the New York Central R.R. are carried over the south channel of the St. Lawrence River near Cornwall, Ont., by a bridge consisting of three 368-ft. single-track truss spans. A recent inspection disclosed the fact that the expansion rollers (of which there are six, 12 in. high, at each expansion point) were inclined considerably more than they should be at the temperature obtaining when the inspection was made, and at two points the inclination had progressed so far that a further movement of ½ in. only was possible. It therefore became necessary to jack up the trusses and adjust the rollers.

The elevation of the bridge above the river, about 40 ft., and the swift current which prevails at this point made the use of any falsework difficult and expensive; the dimensions of the piers, which extend beyond the truss bearings only 4 ft. transverse to the axis of the bridge, and 1 ft. in the other direction, necessitated a compact device for jacking.

The device adopted consisted of a pair of U-shaped lifting rods engaging threaded cast-steel collars which replaced the nuts on the end pins. The rods were threaded at the tops for nuts which rested on loading beams, these beams being in turn supported on lifting beams against the lower flanges of which, through timber blocks, the jacks operated.

The collars were threaded from field measurements of the threads on the pins, and each was provided with a ¼-in. rim at the outer end to hold the lifting rods in position. The latter were made of 1¾-in. square rods to give a good bearing on the collars, and the inside rod was made in two parts with a turnbuckle connection to permit inserting it around the end floorbeam without disturbing the latter. The loading beams were made of two 12-in. channels bolted together through a 4-in. wood-block separator, the bearing of the lifting-rod nuts being taken

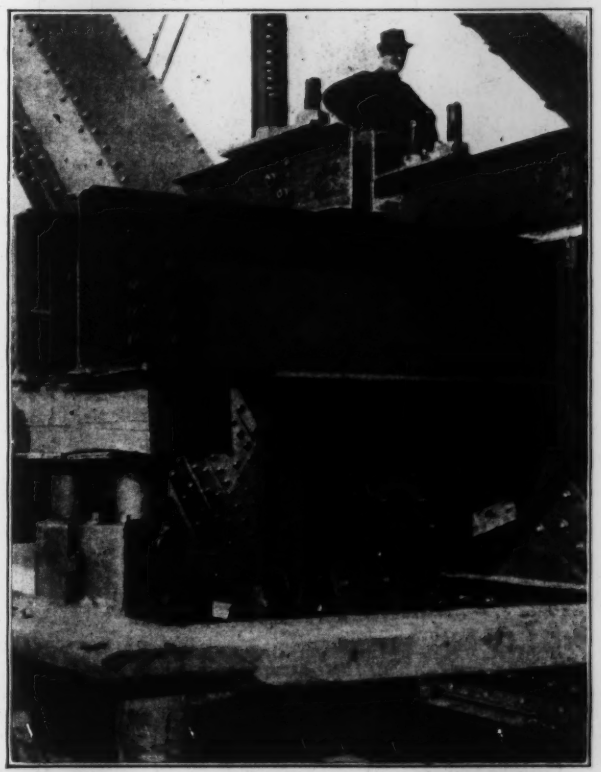


FIG. 1. VIEW OF LIFTING-DEVICE IN POSITION

*Engineer of Structures, New York Central R.R. east of Buffalo, Grand Central Terminal, New York City.

by a ¾-in. plate resting on their top flanges. These beams rested on the top flanges of the lifting beam composed of two 24-in. 80-lb. I-beams 9 ft. 3 in. long which spanned the truss shoe, one on each side of the end floorbeam. At the outer end these beams were connected over the jacking point by a 20-in. I-beam diaphragm, but at the inner end, where the floorbeam interfered, dependence was placed on bolts extending through the webs and clamping the parts together through wooden blocks.

Due to interference from the end-post, the lifting beam could not be placed nearer the top of the pier than about 5 ft., which necessitated the use of blocking. The blocking, because of the restricted area of the pier, could not be arranged to give a very ample bearing area, a high bearing pressure on the blocks resulting (see Fig. 1).

The weight to be lifted was calculated as 280,000 lb., and in order that ample jacking capacity would be available four 60-ton jacks were used.

A force of six men was employed in the work. After the preliminary details—such as drilling holes in the old material and making cuts to permit the placing of the lifting rods and beams—had been completed at all points, the lifting parts and blocking were placed at one bearing, the truss raised about one inch and the rollers adjusted, after which the lifting parts and jacks were removed to the next bearing and the same procedure repeated, and so on until all six expansion bearings were adjusted. Two bearings were adjusted each day. In some cases the roller nest was not exactly square on the bedplate and in addition to adjusting the inclination of the rollers it was necessary to adjust the position of the nest. This was done by means of a small track jack.

During the adjustment of the rollers no traffic was permitted on the bridge, and the work proceeded to completion without interruption or difficulty.

The device was designed in the office of Engineer of Structures, of the Construction Department of the N. Y. C. R.R., and the work was carried out by the Maintenance of Way Department forces under the supervision of the Assistant Engineer, Adirondack Division.

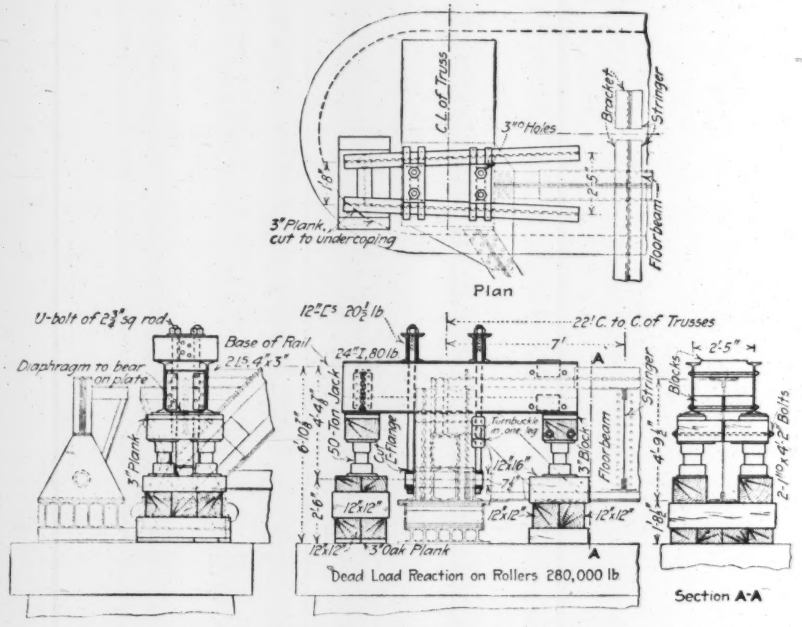


FIG. 2. ARRANGEMENT FOR LIFTING TRUSS TO ADJUST ROLLERS, CORNWALL BRIDGE

⁂

Tar Paint on Penstocks and Draft Tubes has been used successfully at the water-power plant on the Minidoka, Idaho, reclamation project, according to a report in the "Reclamation Record for September." The use of this material appears to have been due to the article on the Fernando siphon of the Los Angeles water supply, published in "Engineering News," May 21, 1914. Barry Dibble, engineer in charge of the Minidoka power plant, found that the steel draft tubes and penstocks under water were not protected from corrosion by the red-lead paints that had been applied. During the fall of 1914 the parts exposed to water on all the draft tubes were scraped clean and repainted with water-gas and coal-gas tar, the former being used for the first coat and the latter for the second and third coats. The steel was first cleaned with steel scrapers and brushes. The cost of the water-gas tar was about 15c. per gallon delivered. One gallon covered about 30 sq.yd. In cool weather, one quart of gasoline was mixed with three to five gallons of tar. The tar was applied with a brush in the same manner as ordinary oil paints. At a cost of labor for painting only of $110, and for material of $10.39, 750 sq.yd. were cleaned and painted.

Load Tests of Concrete Pipe

By E. R. Conant*

In preparation for the construction of 12 mi. of sanitary and storm-water sewers in Savannah, I made a series of load tests on the circular concrete pipe of the Meriwether type, made by the Lock Joint Pipe Co., which type is being used in about 40% of the work. These tests were made under the following specifications:

When supported upon a saddle which extends the full length of the pipe, exclusive of the bell, and whose outer surface fits accurately the outer curve surface of the pipe, and whose width is equal to an arc of 15 deg., in such a manner that an even bearing is provided throughout the whole length, and pressure is applied at the crown uniformly through a knife-edge 1 in. in width, the various sizes of pipe with diameters greater than 42 in. shall withstand the following pressures:

Diameter, In.	Pressure, Lb. per Lin.Ft.	Diameter, In.	Pressure, Lb. per Lin.Ft.
24	2,150	54	5,000
30	2,700	60	5,500
36	3,300	66	6,000
42	3,800	72	6,500
48	4,400		

Bending tests were made on one section each of the 48-in. and 66-in. diameter pipe and on two jointed sections of 36-in. pipe. All concrete was a 1:2:4 mix using river sand and a fine crushed granite for aggregate. The reinforcement was of the standard size and disposition for this type of pipe.

The test on the 48-in. pipe is shown in Fig. 1. In this a load was placed on a 42-in. wide platform carried on a 1-in. knife-edge which rested on the top element of the pipe, the pipe itself being bedded on saddles made by laying two 1x4-in. boards on the ground. The direct load was applied by loading the platform with cement in sacks over a space 4 ft. each side of the knife-edge.

The 48-in. pipe, 48 in. long and 16 days old, showed a hair crack at the invert and crown at 4½ tons load; the deflection was inappreciable. The load was left in place

*Chief Engineer, Savannah, Ga.

FIG. 1. LOAD TEST ON 48-IN. REINFORCED CONCRETE PIPE

unchanged for 24 hr., but no change in the pipe took place. Loading was resumed until 7.35 tons, or 2.08 tons per lin.ft., had been placed. At this load the deflection was 3/8 in. and the cracks in the invert and crown opened up slightly, but no crack extended outside of the inner line of reinforcement. In this pipe American Steel & Wire Co.'s triangular mesh No. 34 was used for reinforcing, two hoops being used—the first one 3/4-in. from the outside face and the second 1 3/4 in. from the inside face of the pipe.

Similiar load test was made on a 66-in. pipe after the pipe had aged 14 days. The loading of 11 1/2 tons was applied on a 1-in. knife-edge, producing a deflection of only 1/16 in. at the crown. A few hair-cracks occurred on the inside of the pipe at the top and bottom.

Another test was made to determine the strength of the joints (Fig. 2). Two 36-in. diameter pipes were jointed with grout in the customary manner, and the pipe was then supported at its ends and load was placed upon a 16-in. saddle centered over the joint. In this test 8 1/2 tons was placed on the loading platform, with the result that no deflection could be noticed and no cracks occurred. The joints thus resisted a bending load greater than the required strength of the pipe.

FIG. 2. TESTING THE JOINT IN LOCK-JOINT PIPE

Subdrainage of Brick-Paved Streets, Lakewood, Ohio

By E. A. Fisher*

I agree with the suggestion of the National Paving Brick Manufacturers' Association that too little attention has been paid to the question of drainage and the action of frost in water-impregnated soils. All the real reasons for the cracking of brick pavements are not fully understood, nor is it to be doubted that the expansive action of freezing water in the subsoil is responsible for some of the trouble. It would therefore seem reasonable to provide, as far as possible, against this cause.

In brick pavements recently constructed in Lakewood, Ohio, I have endeavored to provide subdrainage by placing a 3-in. tile drain behind the curb, laid in cinders as shown in Fig. 1. We used this method of construction last season in all streets with the exception of one. Of those streets in which a tile drain was placed, none has shown any signs of cracking. The one in which no tile was laid has already cracked. Subsoil conditions in the several streets are almost identical.

A condition which exists for about 2000 ft. on one side-hill street which we paved this season is shown in Fig. 2.

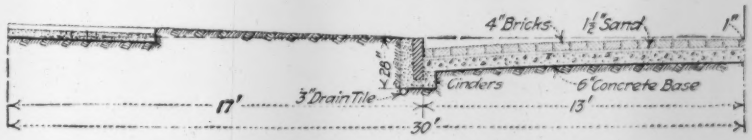


FIG. 1. HALF CROSS-SECTION OF BRICK-PAVED STREET WITH TILE DRAINS BEHIND CURBS

During a hard rainstorm and at intervals afterward, I visited this street to see what effect the tile drain was having. I found the 3-in. tile on the high side of the street, which discharged into the nearest catchbasin, running nearly full. The tile on the low side of the street was running nearly a quarter full.

*City Engineer of Lakewood, Ohio.

In this particular case one can very easily imagine what might happen with the ground saturated by fall rains, followed by a sharp freeze, if there were no tile drain to intercept the water from the slope.

Admitting the theory of capillarity in soils, there may be some question as to where to place the drain. I have worked on the presumption that the presence of 13 in. of

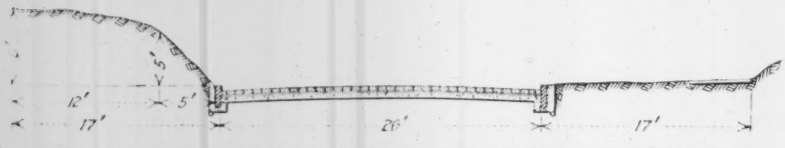
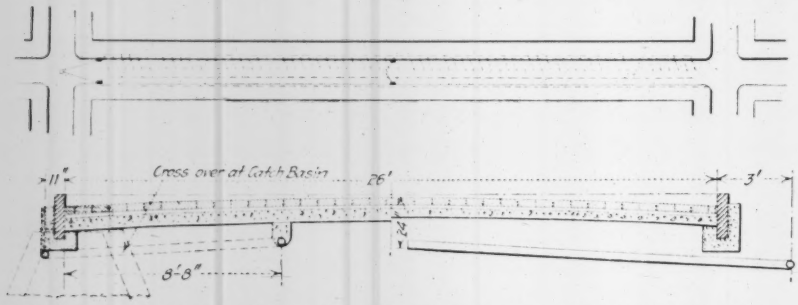


FIG. 2. CROSS-SECTION OF SIDEHILL STREET IN LAKEWOOD, OHIO

porous cinder between the tile and the nearest point of the subgrade would break down any capillarity that might exist.

The N. P. B. M. A. specifications suggest that the drain be placed 3 ft. back of the curb and that lateral drains be run from this tile drain to the center of the street. In Fig. 3 is shown a 600-ft. block with one side of the street drained with lateral tile drains 8 ft. 8 in. center to center and the other side drained longitudinally of the



FIGS. 3 AND 4. PLAN AND CROSS-SECTION OF STREET WITH TWO PROPOSED SYSTEMS OF SUBDRAINAGE

street by two tiles with the same spacing apart. In each case the drain is led to the nearest catchbasin. The saving in lineal feet of tile in the longitudinal drainage over the lateral system is about 30% for the same spacing. Fig. 4 is a cross-section of the street in Fig. 3.

I am firmly of the opinion that there is virtue in the use of a tile drain under the curb, and there may be additional virtue in the lateral drainage suggested. I shall try to find out at the first opportunity.

Explosives for Driving Concrete Piles*

In driving reinforced-concrete piles for the Cabugao Bridge, Ilicos Sur, Philippine Islands, compacted gravel sand, clay and bowlders up to 10 in. diameter were encountered, and it was decided to loosen up the material ahead of the piles by the use of explosives. It was desired to obtain a penetration to El. —6.8 m., the ground level being at approximately El. +0.2 m.

The plan was to explode the charges at El. —6.0 m., leaving 80 cm. of penetration to be obtained by driving the tapered points of the piles into the undisturbed material. Judson powder R.R.P. was used because it was decided this would exert its action through a greater range horizontally and with probably more force upward than other available explosives.

The piledriver was moved into place for driving the pile and a 6-m. length of 3-in. galvanized-iron pipe was hoisted in the leads. A pipe coupling was screwed on to the hammering end of the pipe to protect the threads in driving, and on the driving end was attached a steel cap made of old plate ½ in. thick, 7 in. square, notched on the four sides about 2 in. The corners of the plate were bent up at right angles forming a circle practically the diameter of the outside of the pipe. Into a hole punched in the center of the plate a piece of ¾-in. steel 2 in. long was driven while hot and made snug. The cap was fitted over the end of the pipe at just ground level, and the protruding point served as a guide to keep the cap and pipe going straight. The cap, while it did not keep water out of the pipe, prevented the earth from entering and filling it. While the driver was being moved into place and the pipe was being prepared for driving, the charge of explosives was simultaneously prepared. With light blows of the hammer, the pipe was driven into the ground 6 m.

The charge, really a long cartridge, was lowered into the pipe. The cartridge was a tin tube of 2½ in. diameter and 1 m. long containing Judson powder R.R.P., tamped to a depth of 75 cm. Two sticks of dynamite, with a 6-m. fuse and cap in each, were placed on top of the powder. Another stick of dynamite was broken into four pieces and tamped in around the exploder sticks along with more Judson powder R.R.P. up to within about 4 cm. of the top of the tube. On top of this was rammed some of the thin paper in which fuses are packed, and the tube was sealed with asphalt or white lead, crimping the end of the tube slightly.

When the bottom of the tube was down to the bottom of the pipe and resting on the cap, a 6-m. length of 1-in. pipe was run down on to the top of the cartridge and held there by two laborers on the piledriver. The cable was then hitched to a rope fastened around the top of the 3-in. pipe and with the engine the pipe was gradually withdrawn, leaving the cap and tube down in the ground. The 1-in. pipe was withdrawn after the 3-in. pipe had been lifted about 2 m.

As soon as the two pipes were out of the ground, the fuses were lighted and the charge exploded. The piledriver was then moved into place for the next pile but one and the operation repeated, and then to the second pile beyond that. This gave three explosions for the bent of five piles, which were spaced about 1 m. apart. The concrete piles were then driven with very satisfactory results as to grade, the bearing being much more than required. These facts should be noted:

1. There must be a steel cap on the penetrating end of the pipe as a wooden plug splinters and forces itself up into the pipe.

2. There must be a coupling on the driving end of the pipe as the metal at the base of the threads is too thin to permit of

*Abstract from an article by Frank T. James, in the "Quarterly Bulletin," Bureau of Public Works, Philippine Islands.

hammering without crimping the edges. The coupling also serves as a collar with which to grip the pipe with a rope when withdrawing it from the ground.

3. A block, preferably of hardwood, should be used on top of the coupling as a further protection for the end of the pipe.

4. The 3-in. pipe should not be driven until the cartridge is all ready, because once in awhile the cap slides off the end of the pipe when down at a considerable depth, and the charge must be put in immediately before the earth works itself into the pipe.

5. Dynamite is absolutely necessary to explode Judson powder R. R. P. The manufacturer's handbook states the size and number of sticks to be used for different sized charges. The charge used was about 6 lb. and required two ⅞-in. sticks.

6. In every charge of dynamite there should be two fuses and two caps as a minimum. One fuse and one cap are not enough as oftentimes a fuse that burns well for half its length or more dies before reaching the cap, if the latter has been crimped too much or improperly. Using two fuses and two caps lessens the chances of failure to explode. One of the fuses should be a foot or more longer than the other, and the longer one be lighted first, to insure reasonable safety to the man doing the igniting. This must be done quickly; hence a torch or other large flame is best.

Jacking Tests on Piles

Interesting pile tests were made last spring at the Potter Building, New York City, by Maurice Deutsch, consulting engineer. The piers along the Beekman St. front of the building, on the line of the new subway, were underpinned to a depth of from 56 to 59 ft. below curb, by carrying a series of open pits under the main piers down to water level (about 44 ft. below curb) with five tubular steel-and-concrete piles, of 14 in. diameter, jacked down below the pit bottom to about 15 ft. below water level. Each of these piles was tested to a load of 56 tons by means of a hydraulic jack. Readings were taken on a dial deflectometer. The results of three tests on one of these piles, penetrating 15 ft. in medium fine sand, are shown by the accompanying curves.

SETTLEMENT AND RECOVERY OF PILES UNDER LOAD

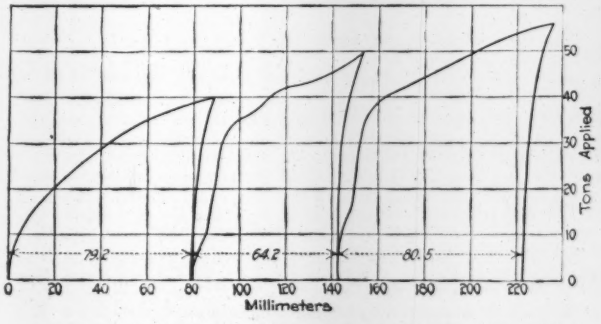
First Test		Second Test		Third Test	
Tons	Movement mm.	Tons	Movement mm.	Tons	Movement mm.
10	4	10	5	10	1
35	60	20	10	16	5.5
40	89.3	30	13	31	9.5
E		35	20	40	20
Recovery.....	10.1	38	30	45	40
		42	40	50	60
Net movement....	79.2	43	50	54	80
		45	60	56	93.9
		48	70		
		50	75.3	Recovery.....	13.4
		Recovery.....	11.1	Net movement.....	80.5
		Net movement..	64.2		

Total net movement 223.9 mm.

It is to be noted that the greatest movement was on the last test, the pile settling at a steady and fairly uniform rate as the load was increased. The recovery on the three tests seems to have been progressively greater as the tests continued and the soil became more compressed. On the third test the application of 10 tons seems to have caused practically no movement, 16 tons being required to obtain approximately the same small movement that resulted from 10 tons in the other two tests.

On the second application of load it took 20 tons to settle the pile the distance it had recovered on the first application, and on the third test 32 tons was applied before the pile settled the distance it had recovered after the removal of the load in the second test. In the third test, after the application of 40 tons, the settlement was more uniform with equal increments of load, than in the previous tests. Commenting upon this particular feature, Mr. Deutsch says:

> This [uniform settlement] would seem to indicate that the soil had reached its maximum resistance to compression, and that the frictional resistance between the pile and the soil having been overcome the settlement of the pile continued uniformly and was subject only to the load increase. The behavior of the soil at this point corresponds to the action of a vibratory force or hammer action applied to a pile or pier penetrating a dense material. The pile that is subjected to a vibratory force will continue to settle so long as this force is applied, and the amount of settlement will increase with the frequency of vibration, assuming the load to be constant, or assuming the frequency to be constant with the increase of the loading.

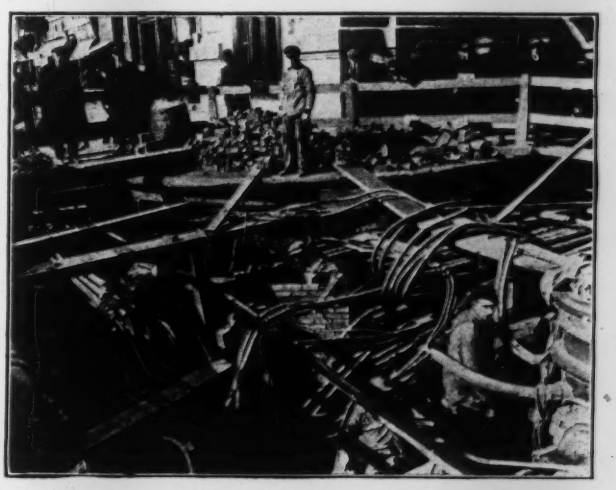


CURVES SHOWING MOVEMENT OF A PILE UNDER THREE SEPARATE LOADINGS

NOTES

Puddled Concrete for Water-tightness was used for the basement wall of the Circle Building, recently erected in New York City. Several kinds of concrete waterproofing were tested by the contractor—the Columbus Circle Construction Corporation—but puddled gravel concrete of 1:2:5 mix was finally adopted, having stood up very satisfactorily under test. The test in question consisted of placing a 2-ft. 6-in. cube of concrete, having a hollow or core which gave 12-in. walls all around, in a trench containing water. After remaining in the water for two weeks no water was found in the core hole in the block. The concrete was puddled with scrapers such as are used to remove ice from sidewalks.

Broadway With the Cover Off is shown in the accompanying illustration. This picture shows the southwest corner of Murray St. and Broadway during the reconstruction of the various subsurface conduits, which carry the means of life



CORNER OF BROADWAY AND MURRAY ST., NEW YORK, SHOWING SUBSURFACE CONDUITS

to the city's many industries. Inquiry is sometimes made why New York City granite-block pavements are constructed with asphalt- or tar-filled joints. The accompanying picture shows the reason why. Grouted joints make a pavement too difficult to open for access to these many conduits.

WARD'S ISLAND BACKSTAY ANCHORAGE OF THE HELL GATE STEEL-ARCH BRIDGE OF THE NEW YORK CONNECTING R.R.

The Ward's Island Backstay Anchorage of the Hell Gate steel-arch bridge of the New York Connecting R.R. is shown in the accompanying view. This backstay is about 2 ft. farther from the west abutment than the east backstay is from the east abutment, but because of a slight bend in the top tie, it requires a heavier anchorage. The picture shown is from a photograph taken July 23, when the anchorage consisted of 3670 tons of steel girders, which will later be incorporated in the east viaduct approach. Before the arch is extended to the center of the span 1500 tons more will be required in this anchorage.

Another Form of Contracted Multiplication—I desire to call attention to a contracted method of multiplication I have used for some time and which I find quite valuable. In order to avoid carrying figures in the multiplication beyond the required precision, I write the multiplier under the multiplicand in the inverted order and proceed to multiply in the usual manner by using only the figures above and to the left of each figure of the multiplier. The position of the unit in the multiplier determines the number of decimal points that will be preserved in the product. In order to gain a precision to any number of decimals, the unit figure of the multiplier should be placed one point to the right of that decimal, thus preserving one figure more than necessary, which figure is used to determine the nearest number required. To illustrate, take 623.85 to be multiplied by 0.71721. In this case two decimal points are to be preserved, so that zero in the multiplier is placed under the third decimal point of the multiplicand, and the sine is written in the reversed order, thus:

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623.850
12717.0
-------
436.695
  6.238
  4.368
    124
      6
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447.431
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Correct value = 447.43
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This accomplishes the same purpose as that sought by E. E. Thum in "Engineering News," July 15, 1915, p. 124, but in a more positive manner. I claim no originality in this matter. The person who explained this to me remarked that this was the only really valuable thing he learned while attending a university.—C. E. Day, Southern Pacific Co., San Francisco, Calif.

Producer-Gas Engine Starts on Gasoline—A producer-gas engine in the pumping station of the water-works of Riverhead, L. I., is arranged to start on gasoline when fire service puts a suddenly increased demand on the station. The engine operates successfully with both fuels, special arrangement being made to suit the gasoline charge to the compression as proportioned for producer gas. The station contains two engines rated at 50 hp. on producer gas or 70 hp. on gasoline. There is a producer for each engine. One of the units is in service for regular operations, but on fire calls it is necessary to start the second. As the producer cannot respond very promptly, the arrangement was made to start this engine on gasoline. A pump-feed carburetor was fitted with a throttle valve in the supply line to the cylinder, so that the charge can be throttled down and a mixture supplied that is not only weak in quality but low in quantity in order to avoid excessive compression and the consequent danger of preignition, etc. By throwing a valve the engine feed is changed from producer to carburetor or the reverse. The engines are Nash engines of the National Meter Co., which also put in the carburetor.

Recording Stream-Flow Gages are discussed by C. H. Pierce in "Water Supply Paper 375-F," issued by the United States Geological Survey. The author favors the use of automatic gages and cites many instances where the records they furnish are far more valuable than would be the record of a gage read by observers at occasional intervals. He further advises a preliminary study of the stream and in many cases the obtaining of preliminary records by portable recording gages before establishing a permanent gaging station.

The Cost of Aërial Tramways is given by a writer in "The Engineer" (London) for July 23, the figures being compiled from actual experience and representing plants which involve no special complications. For lines one mile long, the cost ranges from $11,500 per mile for a capacity of 10 tons per hour to $14,350 for 40 tons and $17,500 for 80 tons per hour. For lines five miles in length, of similar capacities, the cost per mile is $37,000, $52,500 and $65,500 respectively. The estimates are for the total cost of the line erected, and are based on the use of spiral-wound ropes for lines up to 20 tons capacity and locked-coil ropes for from 40 to 80 tons capacity. The operating expense per day is estimated as follows: One-mile tramway, $6 for 100 tons per day, $9 for 400 tons, and $14.50 for 1000 tons. Five-mile line, $12.75, $21 and $39.50 respectively. The operating expenses include depreciation, but not the cost of driving. This latter varies so widely with difference in elevation between terminals, etc., that it cannot be standardized and must be estimated for each plant.

Editorials

Missouri River Navigation

In *Engineering News* of Aug. 26 was noted the official recommendation of Colonel Deakyne, in charge of the United States Engineer Office at Kansas City, that the Government should expend no more money upon the improvement for navigation of the Missouri River below Kansas City. As was to be expected, this report by Colonel Deakyne has aroused great local hostility. A meeting was recently held at Kansas City, attended by 260 delegates from the states in the Missouri and Mississippi valleys, and a committee was appointed to draft a protest to the Board of Engineers for Rivers and Harbors. It was declared that the fight against the abandonment of the Missouri River would be carried into Congress, and the following resolution was adopted:

> Whereas, it is recognized that expenditure by the Federal Government on the Missouri River will greatly deepen the channel thereof and develop it into a great highway of commerce, we do here further call attention to the fact that when the river has been controlled and made navigable it will be kept within bounds and it will incidentally preserve and protect 500,000 acres of land worth $50,000,000 along its banks, now liable to overflow. The value of the land thus restored to the use of the people will be greater than the amount expended by the Government in making the river thoroughly navigable.

One wonders how many of the delegates who took part in this protest seriously believe that steamboat traffic on the Missouri River will ever become important in amount, no matter how much money the Government may spend on the improvement of the stream.

The language of the resolution quoted unconsciously reveals that the real reason why the residents of the Mississippi valley are vociferous in demanding Federal appropriations for navigation is because they wish the Government to pay the cost of reclaiming the lands along the rivers.

The present situation in regard to inland-river navigation in the Middle West may be briefly summarized as follows: The Government has spent an enormous sum, amounting to probably over $200,000,000, on the improvement for navigation of the Mississippi River and its tributaries, but the traffic on these rivers has in many cases entirely disappeared and on hardly a single one is there traffic enough at the present time to justify the expenditure that the Government has made on its improvement. Further, there are no signs whatever that river traffic is to increase in the future. On the contrary, there is a steady falling off year by year. It is admitted by the more intelligent advocates of river improvement that the chief cause of the falling off of river traffic on the inland waterways of the West is not the inadequacy of the channels that the Government has improved, but other causes with which the Government has nothing to do.

There is room for fair difference of opinion as to whether certain inland rivers most favorably situated may not in time, through changes in conditions, become of some value for navigation; but as to the Missouri River below Kansas City there can be no question in the engineering profession but that Colonel Deakyne's opinion is sound.

It may be of interest to briefly summarize a few important facts regarding this stream. The length of the river from Kansas City to its mouth is 392 miles, and in that distance the river falls 325 ft. The river winds through alluvial bottoms for nearly the whole distance and frequently changes its channel. One such change was noted in these columns only a few weeks ago. Including the distance from the mouth of the river to St. Louis, the steamboat route between Kansas City and St. Louis is nearly 420 miles long, whereas the rail distance between the same points is only about 290 miles. The Government has expended over $11,600,000 on this stretch of the river, of which about $5,000,000 has been spent in the last five years. Although numerous steamboats navigated the river in the pioneer days before the advent of railways, steamboat traffic on the river was abandoned many years ago, and the Government, after systematic work to improve the river from 1884 to 1902, abandoned the work. In the River and Harbor Act of 1912, however, Congress adopted a project for improvement of the river below Kansas City at an estimated cost of $20,000,000 to be completed in ten years. This appropriation was due to the energetic campaign which was engineered about that time for Government appropriations for inland rivers.

In order to back up this appropriation with at least a semblance of business on the river, a company was organized in Kansas City to run steamers between that place and St. Louis and great claims were made as to the enormous business which the company would carry on and the great saving which would accrue to commerce by reason of the revival of river navigation. It is of interest to compare this promised performance with the actual result as stated by Colonel Deakyne in his report published in the issue of Aug. 26. He states that the total river traffic on the lower Missouri in the last fiscal year was 37,551 tons carried distances of 8 to 290 miles at a total freight charge of $41,000. If there were any sound basis for the claims of economic advantage in river transportation, certainly the steamers that have been in service on the Missouri River ought to have made a far better showing in the last two years.

The river advocates, of course, will claim that the reason why traffic does not seek the river is that the present channel is inadequate. It is not possible, however, within the limits of any reasonable expenditure to make of the lower Missouri River a navigable channel that will be safe and commodious for vessels at all seasons. The $20,000,000 which the Government proposed to spend on the present project would not secure such a channel. With that amount spent, the river channel would still be far inferior for navigation to that of the Mississippi River, where, as is well known, the river traffic dwindles rapidly year by year.

It is altogether probable that the time has come when the Government will have to abandon its long-established policy of spending money ostensibly to improve navigation

on inland rivers, but actually to enable the local congressman to go home with a story of the appropriations he has secured to be spent within his own district. In the immediate future the Federal Government will have no money to spare for pork-barrel river and harbor appopriations. Expenditures are now running far ahead of revenue. At the coming session of Congress there will doubtless be largely increased appropriations for national defense. Increased Federal taxation will probably be necessary anyway, and with this will come a general public demand that expenditure by the Government on unprofitable enterprises shall be stopped.

Excess Condemnation Proposed in New Jersey

Excess condemnation, or taking more land than is to be used for a public improvement and selling the excess after the improvement is completed, facilitates many classes of work with which the engineer has to do. The practice is rare in the United States, because without specific state constitutional authorization it is generally held that excess land purchases for resale are not purchases for public use. A few states have recently adopted excess-condemnation amendments to their constitution, and on Nov. 2 one already passed by the New Jersey legislature will go before the people of that state. It reads as follows:

> The Legislature may authorize the state, or counties, cities, towns, boroughs or other municipalities, or any board, governing body or commission of the same, to take more land and property than is needed for actual construction in the laying out, widening, extending or relocating the parks, public places, highways or streets; provided, however, that the additional lands and properties so authorized to be taken shall be no more than sufficient to form suitable building sites abutting on such park, public place, highway or street. After so much of the land or property taken has been appropriated for such park, public place, highway or street as is needed therefor, the remainder may be sold or leased and reasonable restrictions imposed.

The aim and effect of this and similar constitutional amendments is to save a city or other governing body from paying the full value of an entire lot for a fraction of it, and perhaps a small fraction at that. Excess condemnation also enables the public buyer to recombine and sell fractional lots resulting from a land taking, gaining for itself a part of the enhanced value due to the improvement for which land is primarily being condemned and thus reducing the cost of the improvement. In conclusion, excess condemnation gives the public purchaser more or less control of the character of the improvements abutting on a boulevard, public square or park.

Concrete Pressure in Forms

The question of the pressure of concrete in forms is by no means as fully explored as desirable. Practice is well ahead of the range of experiment or well-founded formula. Pouring concrete in massive structures to about 30 ft. depth in a day's run has been done on both the Brooklyn-Brighton and the Detroit-Superior viaducts, the former case being noted in last week's issue. But measurements of pressure do not go to such depths, and no one knows reasonably closely what the pressures on the forms are in such cases. The depth of pour at which transmission of pressure begins to be interfered with is estimated variously by different persons, from 2 hr. pouring depth to 5 hr.

Usually it is assumed that concrete pressure is exactly the same in character as hydrostatic pressure. If so, then an arch ring of 50 ft. rise should, if concreted within a shorter time than that required for a set sufficient to destroy the hydrostatic character, exert an outward pressure upon the forms at the skewbacks corresponding to 50 ft. head, or 5,000 to 6,000 lb. per sq.ft. This is so great a pressure that it would be hard to hold with anything in the way of form ties now in use. Arch rings of nearly this rise have been concreted—most of the rise in half a day—without the use of forms having such enormous strength. Was the pressure reduced not only by set but also by friction in the forms? Is "liquid" concrete really semigranular material rather than a fluid?

Arch work in concrete has developed with the general progress of the concrete industry. Not very long ago the construction of a 150-ft. concrete arch gave rise to elaborate planning and preparation of drawings to guide the contractor in sectionalizing the concreting of the arch ring. The concreting extended over many days; the several ring sections were bulkheaded off and keyed, the reinforcement was spliced at the key blocks, and a very complex job was made of the whole. Nowadays such a ring is likely to be concreted in one day's run, and the elaborate sectionalizing is unnecessary. The resulting advantages are such as to invite consideration of the same procedure for much larger arches. The cost of installing the extra plant for mixing and placing would doubtless be well repaid by the saving in labor, expense and delay.

The question of liquid concrete pressure in an arch ring may therefore become an immediate practical question in the near future. Present experimental study does not furnish an answer. Further research is needed, based on a well-devised plan of experiment and carried out by able investigators. Possibly such a body as the American Concrete Institute might initiate the work and provide the means.

The Delayed Bidder's Case

An intending bidder who fails to get his bid in on time is not entitled to submit a late bid, even though his delay was due to an act of God. The question came up a few weeks ago in connection with a rapid-transit contract in New York City.

The Public Service Commission received bids closing Aug. 4 at 12:15 p.m. for certain station finish. The preceding night had been one of remarkably heavy rain. After the bids closed a representative of the Marble Arch Co. appeared and offered to submit a bid, stating that he had been held up by the rainstorm and by a block on the subway. The offer was refused. On opening the bids the lowest bid was computed at $268,102.50. Later the Marble Arch Co. served notice to show cause why a writ of mandamus should not issue, directing the commission to accept his bid, stating that it was lower than the lowest of the bids opened. The subsequent decision of the court on this question was to uphold the action of the commission in rejecting the offer to submit a late bid, in spite of the fact that the applicant set forth a detailed account of his difficulties in reaching the office of the commission.

The decision of the court is in accord with the dictates of common sense; had the outcome been different all sorts of peculiar situations might arise in the future to harass the commission and delay construction.

⁂

An opinion of the United States Supreme Court on the once hotly debated question of enhanced value of water or gas mains because of improved paving over them is sure to arouse interest. In the recently announced Des Moines 90c. gas case is a finding in this matter which will meet the hearty approval of many, and perhaps of most, engineers. The court makes no comments of its own, but accepts and promulgates the statement of a master-in-chancery for the court below. The master decided that the life of mains was not increased by the need for removing new paving when the mains had to be taken up, that the owners of the mains had acquired no property right in the paving, and that there was no justice or equity in increasing the price of gas because the company might have the replace the pavement.

This same case is of timely interest, as it gives a forecast of the court's decision in the Passaic 90c. gas case, which has attracted great attention for two years. From what has been published in these columns (Jan. 21, June 17, and July 1, 1915) it will be recalled that the New Jersey Public Utility Commissioners in appraising the property of the Public Service Gas Co. refused any substantial value for franchises and the State Supreme Court upheld them. The Court of Errors and Appeals first reversed the Supreme Court (taking the ground that franchises were company property and that the value was indicated by the market value of the company's securities) and later reversed itself (one judge explaining that franchises were property, but not "property used and useful in the public service"). The case is now before the United States Supreme Court on appeal. The Des Moines decision does not touch upon franchise value specifically, but it dismisses value for good will, past earnings and paving over old mains. The next consistent step will be a general denial of franchise value—beyond that due to cost and burden. Such an authoritative pronouncement on what to include in the basis of rates will clear away the haze that now involves this matter.

⁂

Word comes from Philadelphia that the "voluntary installation of [water] meters is proceeding at an unexpected rate." Moreover, incentive being offered by the water bureau led the *Bulletin* to declare that "the 2 per cent. of the service which is now metered ought to show considerable expansion" in September. Evidently the "unexpected rate" has not been maintained long or would be "unexpected" only in Philadelphia. Seriously, any noticeable acceleration in the installation of water meters in Philadelphia is encouraging.

Letters to the Editor

Should Another Course Be Added to the Engineering Schools' Curriculum

Sir—The latest progress report of the special committee of the American Society of Civil Engineers appointed to investigate the conditions of employment and compensation of civil engineers shows among other things that the average compensation of nongraduates with from two to fifteen years' experience exceeds that of graduates with the same amount of experience. A still greater discrepancy in favor of the nongraduates would undoubtedly be found if engineers outside the membership of the society were studied, as then more of the younger graduates would be included.

This is owing, no doubt, to the lack of field experience in the young graduate and to the results which the nongraduate can secure with his practical knowledge. The condition disclosed by the committee's report is due, in a large measure, to the technical school. The curriculum rightly embraces theories and underlying principles, but it does not include in any adequate measure the art of applying these principles and theories to practical use.

The engineering student devotes hours to descriptive geometry and calculus, but can he cut out a pattern by which an elliptical sheet-metal pipe can be made which will fit a hypocycloid of revolution at any given angle, if such should be required on his first job? He can draw detailed plans for a timber roof on an ordinary dwelling house, but can he show the carpenter how to cut a jack rafter to fit the hip rafter? He can design a 100-ft. plate girder down to the last rivet, but does he know the first thing about how to place it upon its abutments, or how to build them? In most cases, No.

It will be argued that designing and constructing are in entirely different fields. That is true, but a man is a better designer if he knows the erecting end. His detailing of connections, etc., will be better if he is able to view them from the standpoint of the man in the field who has to erect. *Vice versa,* the construction man will do better work if he is conversant with designing methods and principles. Every construction engineer has repeatedly come across details in plans which have either been impossible or expensive. Most of them would have been obviated had practical experience been combined with theoretical instruction.

About a year ago the writer was asked to address a student engineering society, and in conversation with one of the young men interested, intimated a desire to speak upon "What do you know at graduation." When an explanation was sought, the reply took the form of a hypothetical question: "Suppose you had to erect a 100-ft. steel flagpole, lay the necessary foundation and place the guys and guy anchors. You could, no doubt, compute the size of the pole necessary to take care of all possible wind stresses and to meet all other conditions. You could calculate the sizes of the guys and the weight of anchorage necessary and the number of yards of con-

crete to form the anchorages and foundation. But how would you put the pole up in the air? Could you say how many barrels of cement, how many cubic yards of sand and of gravel would be necessary to make the concrete?" The young man saw the point, for he did not know the first thing about the raising of the pole. Yet a man with two years of experience (the equivalent to a degree in the American Society requirements for admission) on construction work would probably have answered at once.

Technical colleges, of course, are not intended to turn out finished and thoroughly competent engineers. But they should not graduate men, as they do, who know nothing whatever of the tools, equipment and methods of construction. Graduates are put forth upon an unsuspecting world who do not even know the names of many of the tools and much of the equipment with which they have to deal; they have only a hazy idea of the way work is done and practically nothing of the unit costs of such work.

The direct cause of this condition is perhaps the fact that instructors and professors, in general, are men with very limited construction experience. Many have devoted practically all their time since graduation to the classroom; they are well-grounded in theory and quite naturally deficient in its application, so that they fail to see the importance of the construction side of engineering.

It seems to the writer that, as a remedy, a course in engineering construction might be a very desirable adjunct to the curriculum of the technical college. A chair of this sort should be filled by a man who is well-grounded in theory and who has had a fairly extensive experience in actual construction of engineering works of the class which the graduate would be most likely to encounter early in his career.

The course should embrace the ordinary construction which the young engineer might be called upon to plan and supervise—such as all classes of concrete work, excavation, foundations, sewers, water-works, pavements, buildings and bridges. It should also include falsework, rigging, etc. The student should be acquainted with the field for various kinds of tools from pick and shovel up and should be given instruction as to when and how to use them. Next should come the kinds and uses of the various power equipment. He should be taught how to tie knots and to rig derricks, hoists and such equipment.

Methods of doing various classes of work might be taken up in the classroom. Instruction would probably be given as to what equipment to use in specific cases, such as, for example, dry-earth excavation under various conditions, excavations in wet earth, in rock, under water, in quicksand. The temporary works necessary, such as sheetpiling, falsework, coffer-dams, forms and underpinning, would also be studied. Quantity surveying should also be included, both for the finished structure and for all temporary works. Unit costs of the more common elements under varying conditions might well be added; this should also include cost accounting and distribution. The instructor, from time to time, could introduce new features, such as floods, storms, etc., which would correspond with actual unforeseen contingencies.

As a summation, problems should be given which would combine all these; for example, a concrete-arch bridge is to be constructed from plans furnished. The foundations at one end are 10 ft. below the water level and in treacherous soil requiring piling; at the other end solid rock is encountered. The student should work out the problem from the knowledge he may have previously gained. He should first, perhaps, outline the methods by which he would do the work. In other words, he should design his construction plant. This would include making a list of all the tools and equipment that he would deem necessary, as well as of all material for the construction and assembling of the plant. Next would come a bill of material for the entire job from inception to completion. An outline of the various steps in the progress of the work would be in order, together with the methods to be used in each case. In short, the student should plan the work just as an experienced man would do if he had to do the work in the heart of Africa—with no convenient base from which deficiencies might be supplied. Of course, the student could not do this as well as an experienced man could, but he would do better than he could if he had had no previous instruction. As a finality, an estimate of cost and time should be prepared.

Work of this nature could probably best be given by lecture courses, supplemented by visits whenever possible to scenes of work in progress. Students should be urged to secure positions—or merely "jobs"—on construction works during the summer vacations, for which credits should be given. A young man with pick and shovel, if he keeps his eyes open, can learn a great deal in one summer.

A course of this nature, as roughly outlined, would undoubtedly prove to be one of the most interesting and popular, as well as beneficial, in the entire curriculum, and deservedly so. It would also do much toward securing better initial salaries for the graduate.

The writer is not attempting to disparage the teaching of theory, nor advocating the transformation of our technical schools into mere trade schools. He is appealing for a happy medium in combining theory and application, believing that such a combination would benefit both school and graduate, and eliminate much of the criticism of the product now placed upon the market.

R. C. HARDMAN.

Colorado Springs, Colo.

[We give space to Mr. Hardman's letter because it represents a type of criticism of the technical school which one frequently hears, but for which there is perhaps less justification than many suppose. A number of the technical schools are attempting to give just such practical instruction as our correspondent proposes, and have long done so. One member of the editorial staff of this journal, for example, recalls being given as a freshman in Cornell, fifteen years ago, the identical problem as to the practical method of erecting a flagpole which our correspondent suggests. The real trouble with our technical schools, as we see it, is that through a misinterpretation of such criticisms as that of our correspondent they have loaded up their courses with a mass of technical detail and have multiplied courses and specialized instruction, so that the tendency is toward the production of specialists rather than all-around engineers. But in imparting fundamental knowledge and giving rudimentary training the practical side can be emphasized more successfully than now is generally done.

There is a limit to the amount of information one can cram into a youth in four years; and he ought to get out of his college course a development of character and personality that he may miss if he has to grind on purely technical studies all the time.

It is obvious, however, that detail instruction on field and shop and office methods in all the various branches is attempting the impossible. How many engineers of ten years' experience have any practical knowledge of construction work and methods outside the fields in which they have been directly engaged? Suppose it were attempted to make students in their four-year course familiar with the construction methods now in use "in all classes of concrete work, excavation, foundations, sewers, water-works, pavements, buildings, bridges, etc."—we quote the list from our correspondent's letter. There is enough in this list alone to consume all the time of a four-year course, and this of course is only a beginning in enumerating the different fields of work in which a civil engineer may engage.

The real trouble, it seems to us, lies in the fact that the engineering schools are expected to turn out *engineers* at graduation, whereas their aim should be to turn out men so well-grounded in the fundamental principles and methods applicable to all sorts of engineering work that they will have this knowledge and ability as an aid in whatever sort of engineering work chance directs them toward—for in nine cases out of ten, it is chance, and not specialization in college studies, that determines in what sort of engineering work a graduate will find employment.

We would not be understood, however, as urging that engineering instruction should be purely theoretical. All the subjects in an engineering school should be taught as *applied* science; and the ability to apply it is as important as the science.

What does seem to us objectionable is attempting to teach in an engineering school a lot of detail relating to special fields of engineering work, which the student will never use unless he chances to fall into that particular field. It is said of course that such instruction is useful mental training, but it should not be forgotten that there is an elastic limit to the mental machinery of the students. The world is afflicted nowadays with societies devoted to almost every subject under the sun, but there may yet be room for a society for the Prevention of Cruelty to Engineering Students.—Editor.]

Engineering-Society Publicity

Sir—I read with much interest F. H. Newell's letter on "Public Speaking for Engineers," in *Engineering News* of Aug. 5, 1915. Mr. Newell rightly places much emphasis on the importance of engineering publicity, which has been woefully neglected by the profession. Not only has the young graduate engineer a marked lack of self-expression; the older engineers are guilty to a large extent of the same disability.

It is my opinion that the self-centered aloofness of the engineer and his hesitancy to discuss matters of public interest and welfare without remuneration has been one of the causes of failure on the part of the public to appreciate the importance of the engineer and to make proper recognition of the profession.

A rough outline of a scheme of publicity for local or sectional engineering societies which would lead to very desirable results in elevating the plane of the engineer as a professional man and in benefiting the individual members of the society is here suggested.

Publicity committees composed of men proficient in their respective branches of engineering would be elected or appointed for a term of three to six months (depending on the number of members, the idea being to give all members a chance to serve on such work). The duties of these committees would be to keep in touch, through the aid of the secretary, with questions of public interest and to prepare and submit articles on these questions to the various newspapers in the city and vicinity; also to report on disasters or accidents related to engineering. Of course such matter should be written in language readily understood by the average reader.

The various engineering societies should become active in publicity work in order that we may be freed from the sensational, untruthful and harmful reports on accidents to engineering works so common in the daily press.

ALBERT M. WOLF.

Chicago, Sept. 4, 1915.

The Flat-Slab Patent Suit

Sir—I note in your issue of Aug. 19, 1915, p. 379, you publish a statement relative to the contempt proceedings in Minneapolis, in the case of the alleged infringement of the Norcross patent for concrete flat slabs. That statement was not complete.

Judge Morris, who decided the matter, said that he considered it was up to the Court of Appeals to decide the scope of the Norcross claims and he did not understand clearly how the ruling which he was bound by was consistent with the state of the art. For that reason he decided to fine me nominally $200, not to be paid until after the matter was passed upon by the Court of Appeals, and that this fine was made payable into the United States Treasury in order that an appeal to the Court of Appeals would lie and the matter could be more fully threshed out by it.

C. A. P. TURNER.

Minneapolis, Minn., Aug. 27, 1915.

NOTES AND QUERIES

Errata—W. G. Peters, Deputy County Engineer, Chehalis, Lewis County, Wash., sends the following corrections to the "Table of Square Feet Reduced to Decimals of an Acre," p. 363, "Engineering News," Aug. 19, 1915:

510 sq.ft.	reading 0.0171	should read 0.01171
27,200 sq.ft.	reading 0.62242	should read 0.62442
35,700 sq.ft.	reading 0.81596	should read 0.81956
42,700 sq.ft.	reading 0.98206	should read 0.98026

The Paddle Wheel as a Pump—In response to the inquiry, in this column of the issue of Sept. 9, about scoop wheels built and used in this country, John H. Cook, Hydraulic Engineer, 158 Ellison St., Paterson, N. J., writes that there is a paddle wheel that is used as a pump at the Morris Canal and Banking Co.'s station on the Hackensack River, not far from the Newark Plank Road in Jersey City. This wheel is about 12 ft. across the breast and is operated by an old walking-beam engine that was built about the year 1856. The water is lifted about 5 ft.

Water-Pocketing in Two-Angle Members—This is urged by A. R. Astbury, Provincial Executive Engineer, Winterfield, Simla, against such a design of member. In light pony-truss highway bridges, where extreme lightness and compactness are necessary on account of pack transportation (weight limit 150 lb., length limit 12 ft.), the two-angle member with angles spread enough to take the gusset-plate is economical, but rapid rusting is feared from water-pocketing between angles. Suitable designs would be appreciated.

Measuring Drainability of Imhoff Tank Sludge*

The thorough digestion of organic matter in the sludge compartment of a mature Emscher tank results in a destruction of the sticky colloidal matters, a breaking down of organized bodies into finely divided particles, and a material reduction both in the volume of the sludge and in its percentage of moisture. It also causes the presence of gas, which is compressed when the sludge is in the bottom of the tank, but which expands when reduced to normal pressure as the sludge is withdrawn.

This expansion causes the solid portion of the sludge to float upon the water, which, owing to the conditions described, very rapidly separates at the bottom. For these reasons such sludge, applied to underdrained sand beds, will dry sufficiently to be removed in a few days instead of probably weeks or months with other kinds of sludge.

The methods of sludge analysis in most common use consist in determining the percentage moisture and specific gravity of the wet mass and the percentage of the dry residue that is fixed and that which is fat or soluble in ether. These tests are principally of value to show, in an indirect way, the good or bad qualities of the sludge, and it seems that an additional test is required to measure drainability.

The real and essential properties of sludge, when it must be disposed of on land adjacent to habitations, are odor, volume and drainability. I am not acquainted with any better apparatus than the nose for determining the first, a foot-rule for the second, and for the third the results of a few experiments are here offered in the hope that from them a simple test may be devised.

Since April of this year a composite sample of each batch of sludge placed on the drying beds at the Pennypack Creek sewage-disposal works (Philadelphia) has been submitted to the two following procedures:

A portion amounting to 700 c.c. is placed in a 1,000-c.c. measuring cylinder and the amount of clear water separated at the bottom observed and recorded at hourly intervals. This is continued until the sludge begins to settle down into the water again.

Another 700-c.c. portion is placed in a vertical piece of glass tubing of the same internal diameter as the measuring cylinder. Over the lower end of the tube is secured a piece of wire screen which supports a ½-in. layer of small pebbles, a ½-in. layer of clean Jersey gravel, and a 2-in. layer of fine sand. (The thickness of these layers could probably be reduced and thereby decrease the amount of entrained drain water.)

The tube is held in a retort stand over a funnel resting in a measuring cylinder to collect the water draining out of the sludge, and the accumulated amount of water is read at hourly intervals until the sludge ceases to drain. The results of these measurements are plotted in terms of c.c. of separated water and time.

In several instances the sludge placed in the measuring cylinder has begun to float on the water, after a few hours settled down, then separated and floated again. Such action prevents obtaining a useful curve of drainability, and it appears that the tube with filtering media is the better method.

*Condensed from a paper presented to the Sanitary Engineering Section of the American Public Health Association, Rochester, N. Y., September, 1914, by W. L. Stevenson, Assistant Engineer, Sewage Disposal, Philadelphia.

An examination of the curves [not here reproduced—Editor] indicates that the factors which should be combined to obtain a number to represent the drainability of the sludge are:

a. The rate of drainage represented by the slope of the first part of the curve.

b. The ratio between the amount of water drained from a liter of sludge and the amount of moisture therein as determined by the usual evaporation method.

c. The time required for the water to begin to drain out.

Good sludge will be indicated by (a) having a steep slope, (b) showing a large number for the ratio, and (c) showing a short time; bad sludge the reverse.

No attempts have been made to combine these three factors to form a number similar to the relative-stability figure for filter effluents, because the data are too meager and only sludge from one works treating a sewage which is two-thirds institutional has been used in the experiments. But I believe that more extended study in some of the sewage-works or testing-station laboratories might develop a simple field test capable of being made by the type of operator usually found in the smaller works and that its use would serve to indicate a very important characteristic of Emscher tank sludge.

Convention of the New England Water-Works Association

The 34th annual convention of the New England Water-Works Association was held in New York City, Sept. 7-9. The registration was well over 600, and all the meetings were fairly well attended considering the many other attractions in the city and the extreme heat of the weather. Following the usual addresses of welcome and other preliminaries, the following subjects were discussed:

New York City Water-Works

The water-supply and water-works of New York City were naturally subjects of much interest. The present status of the new Catskill water-supply was described by J. Waldo Smith, Chief Engineer of the Board of Water-Supply. This work is rapidly nearing completion and another spring will see its real test in service. Mr. Smith frankly stated that because of the much new and unprecedented construction he expected to find that details would have to be revised and changes made before reaching an entirely satisfactory conclusion of the work.

The sanitation of the Catskill watershed was described by George H. Honness, Department Engineer of the Board of Water-Supply, and the forestation of the watershed was described by Sidney K. Clapp, Assistant Engineer of the Board of Water-Supply. Mr. Clapp's paper was unusual in the wealth of detail given; it covered the gathering of the seeds, planting, keeping off birds and mice, preventing mildew, exterminating grubs and field mice, and precautions against winter killing of the young trees. The forestation work of the Board of Water-Supply is more for landscape work than in expectation of utilizing the trees later for commercial purposes.

The forestation of the Croton watershed was the subject of a paper by T. C. Culyer, Assistant Engineer, Department of Water-Supply, Gas and Electricity. The concrete wire-fence posts used in the Catskill drainage areas were described by Ralph N. Wheeler, Department Engineer, Board of Water-Supply.

The Kensico dam and reservoir were described by Wilson Fitch Smith, Division Engineer, Board of Water-

Supply, and a very enjoyable excursion was made to the dam Sept. 9. Although the temperature on that day was around 90 deg., a large party took the special train to Valhalla and toiled up the hill to the top of the dam. Very few, however, could be induced to visit the quarry, which is about a mile from the dam.

The water-supplies of some Long Island sections of the city were described in considerable detail by W. F. Laase, Assistant Engineer, Department of Water-Supply, Gas and Electricity, in a paper, "Infiltration Galleries as a Source of Water-Supply on Long Island."

The laying of water pipe in the congested streets of the city was the subject of a paper by M. Blatt, Assistant Engineer, Department of Water-Supply, Gas and Electricity. As a typical instance Mr. Blatt described the installation of the downtown high pressure fire-protection mains. No records of subsurface structures were available when the work was started, and it was first attempted to obtain a plan of these pipes and conduits by digging test pits at intervals. Subsequent experience proved this was not feasible, and the work was carried on without knowledge of the subsurface conditions to be met, except such as could be obtained from test pits immediately in advance of the trenching. Much reconstruction of existing structures was required before room could be found for the new mains.

The electric operation of valves on the high-pressure fire-protection system was described by Alfred Williamson, Mechanical Engineer, Department of Water-Supply, Gas and Electricity.

The locating of a leak in a 12-in. submarine main crossing to Riker's and North Brother Islands was described in a paper by E. G. Hooper, Assistant Engineer, Department of Water-Supply, Gas and Electricity. The chief feature in the method used was the determination of the hydraulic gradients on different parts of the line by means of pressure gages; the point where the gradient shifted, being the place where the velocity changed, denoted the vicinity of the leak.

Water-Supplies of Other Cities

The double sand filtration plant for the purification of the water-supply of South Norwalk, Conn., built about 7 yr. ago, was described by H. W. Clark, Chemist, Massachusetts State Board of Health. This plant, according to Allen Hazen, is the most complete in this country for the removal of tastes and odors. Portions of the water treated, Mr. Clark said, are sometimes about the color and consistency of thick pea soup. No difficulties have developed in its operation. The interest on the $100,000 investment and the cost of operation amount to about $10,500 per annum.

A joint additional water-supply for the cities of Salem and Beverly, Mass., was the subject of a paper by F. F. Longley, New York City. The most interesting features of this work were the survey of a 9,000-acre swamp and the building of a canal through this swamp from the Ipswich River to a pumping station near the present reservoir. The canal was so feasible that it was built instead of a pipe line as first proposed.

Recent improvements to the water-supply of Fall River, Mass., were described in great detail by H. K. Barrows, Boston, Mass. Here water is taken from a natural pond close to the city, which contains only a limited supply. The pumping plant is an old one and as not sufficient storage is provided for a single day's supply (5,600,000 gal.), the city has not much margin of safety. The improvements noted were the establishment of an independent electrically operated pumping station for emergency use and the improvement of the water-supply itself by the gradual acquirement of the watershed by the city. The greater part of the paper was a detail description of the construction of a covered reinforced-concrete drain.

Water-Main Joints—Use of Leadite

The use of leadite for water-main joints was the subject of two papers—one by Henry A. Symonds, Consulting Engineer, Hanscom Construction Co., Boston, Mass., and the other by W. C. Hawley, Chief Engineer and Superintendent, Pennsylvania Water Co., Wilkinsburg, Penn. Both were in favor of the use of leadite. Mr. Symonds emphasized the necessity of skilled labor. Practically the only unsatisfactory experience he had had was on sharp curves, where the thin wedge of leadite broke out in some instances. However, he stated that he believed satisfactory results could be obtained with proper care under any and all conditions. Mr. Hawley said his earliest experience with leadite was unsatisfactory, but that now after nine years' trial he had come to use it exclusively; some failures he believed were caused by improper manipulation of the material and some by collusion among the calkers, who would be thrown out of employment if leadite was adopted. He laid considerable stress on the effect of leadite in preventing electrolysis. A. E. Martin, Superintendent of Water-Works of Springfield, Mass., and other speakers gave their experiences, in which it was brought out that although leadite joints sometimes show leakage at first, generally within 24 hr. they become water-tight.

Leakage from lead-jointed mains was discussed by Arthur H. Smith, Engineer of the Associated Factory Mutual Fire Insurance Companies, Boston, Mass. This paper contained a valuable compilation of data from a variety of sources, from which the author drew the conclusion that water-tightness was an impossibility and that a leakage of 1 gal. per day per lin.-ft. of joint was to be expected in good and acceptable work. Many instances were quoted where existing mains show a much larger leakage. It was generally agreed that all mains should be fully tested for water-tightness of the joints before acceptance, but that in few cases was this feasible before the pipe trench was backfilled, although this was preferable. Deferring the backfilling to know if the joints were water-tight does not seem to be general practice except where the work is in outlying districts. It was also questioned whether it was good policy to leave the pipe uncovered any length of time, as the increased effects of temperature changes led to expansion and contraction and the opening of joints.

The need of a standard to determine just what leakage should be allowed was keenly felt and upon the motion of William F. Sullivan, Engineer and Superintendent, Pennichuck Water-Works, Nashua, N. H., a motion was passed to have the president appoint a committee to investigate this subject.

Experience with Water-Main Gate Valves

An interesting discussion of gate valves was started by two papers—one by Geo. H. Finneran, Assistant Superintendent of Water Service, Boston, Mass., on the reasons for adopting the solid-wedge type of valve in Boston,

and the other by John M. Diven, Superintendent of Water-Works, Troy, N. Y., on the reasons for using the double-disk valve. In Boston solid-wedge valves have been used since 1848, when the present water-works were begun. The city has its own shops, where all these valves under 12 in. in size are made. Mr. Sullivan believed the governing consideration was mechanical simplicity, and as the solid-wedge valves possessed this virtue and had always given satisfactory service, there was no reason for abandoning their use. Mr. Diven based his arguments in favor of double-disk valves chiefly on the fact that manufacturers have practically abandoned the manufacture of any but this type and that the most popular type must be *per se* the best type. Much interesting information in regard to the actual wear of valves was brought out in the discussion. The manufacturers of valves were given the privilege of the floor, but none availed himself of it.

Miscellaneous Subjects—Meter Testing, Etc.

The work of the New York City Department of Water-Supply, Gas and Electricity in developing tests for meters was described by F. B. Nelson, Assistant Engineer of the Department. The city of New York does not own water meters, but any water consumer may purchase a meter and pay for his water in that way if he so desires. The point emphasized in Mr. Nelson's paper was that meters of different makes for the same-sized service vary a great deal in capacity (64%) and an attempt is being made to rate them by taking this into account.

The control of public water-supplies by the Conservation Commission of New York State was the subject of a paper by Russell Suter, Assistant Civil Engineer of the Commission, Albany, N. Y.

The results of a study of data collected chiefly in connection with the Metropolitan Water-Works of Massachusetts on the decolorization of water by storage were given by Ralph H. Stearns, Boston, Mass. Although Mr. Stearns had a well-developed theory, this was questioned by several speakers. Allen Hazen pointed out that there were so many uncertain elements entering into the problem that it was difficult to arrive at any general conclusions.

The use of wood pipe generally, and in New Hampshire in particular, was described in a paper by A. W. Dudley, Consulting Engineer, Manchester, N. H.

Association Business Transacted

The most important business transacted was the appointment by the president of a committee to investigate and tabulate leakage of water-main joints, with the end in view of establishing some standard of water-tightness for both old and new mains. The committee appointed is F. A. Barbour, Consulting Engineer, Boston, Mass.; Carleton E. Davis, Chief of the Bureau of Water of Philadelphia; Samuel E. Killam, Superintendent of Pipe Lines and Reservoirs, Metropolitan Water-Works, Boston, Mass.; Caleb Mills Saville, Chief Engineer of the Board of Water Commissioners of Hartford, Conn.; Henry B. Machen, Borough Engineer, Department of Water Supply, Gas and Electricity, New York City, and Arthur H. Smith, Engineer, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

Three past-presidents of the association were elected to honorary membership. They are Edwin C. Brooks, of Melrose, Mass., former Superintendent of Water-Works of Cambridge, Mass.; George A. Stacy, Superintendent of Water-Works of Marlboro, Mass.; and Robert J. Thomas, Superintendent of Water-Works of Lowell, Mass.

This nominating committee to choose the officers for 1916 was appointed: F. A. McInness, Boston, Mass.; E. W. Kent, Newport, R. I.; J. Waldo Smith, New York City; E. E. Lochridge, Springfield, Mass.; A. E. Blackmer, Beverly, Mass.

It was proposed by Charles W. Sherman, Consulting Engineer, Boston, Mass., to honor the late Dexter Brackett, past-president of the association, by establishing a fund to be raised by subscription, the income of which might be used as a prize for papers, for research work, or any other purpose that the executive committee might decide upon.

Awakening of the Engineer*

By F. H. Newell†

Now is the day of awakening of the engineer as a man and as a citizen to a larger realization of his duty to society in general, to his profession, and to himself in particular. He is not alone in this. A world-wide war has shocked into new life many dormant conceptions and has opened the eyes of mankind to the larger claims of brotherhood.

The quality that distinguishes the engineer as a professional man from his brother the mechanic is education. The engineer is undoubtedly benefited if at the same time he is a good mechanic, although he may be a success even if he has little or no mechanical ability. To be an engineer in the true sense, he must have, however, that education which enables him to understand the true perspective of things, to know the big from the little, to obtain facts and judge correctly from these.

What is the service which all engineers should be eager to render and which is the fruition of years of training? What do we mean when we claim that the highest function of the engineer and his greatest reward are found in effective service? The word conveys the idea of help rendered to another, not as a favor involving an obligation, nor on the other hand as a matter of self-sacrifice. It is something that may be expected though it cannot be demanded, and may be performed among equals. Service consists of those acts that tend to lessen trouble or increase the health, prosperity and convenience of others.

Engineers in performing service are by this very fact entitled to full recognition. Service implies a suitable reward, and while the effort may be altruistic, it does not involve unnecessary self-denial. A proper remuneration—one assuring a good living—is due to the engineer. He that performs service rightfully does it with full expectation of reward, directly or indirectly, in the satisfaction of duty well done.

Engineer's Service to the Public

Among all the various occupations there is none more capable of leading in service to mankind and in realizing higher ideals than engineering. The engineer should be a man of vision—a missionary of light and progress. His life is devoted to careful, impartial measurement and

*Extracts from an address before the American Association of Engineers, Chicago, Sept. 14, 1915.

†Professor of Civil Engineering, University of Illinois, Urbana.

weighing of facts. He cannot afford to be deceived or to mislead others on these facts; having ascertained them in their true proportion, it is then his business to idealize, to plan, and to use his ingenuity in devising methods for adding to the comfort and convenience of mankind—such for example, as through better conditions of transportation, of communication, of heating, lighting, water-supply and of the things which tend to produce better health and longer life in the community.

In this work the engineer is far ahead of the public. The latter in many ways has not yet caught up with the growth of knowledge and does not appreciate the possibilities that are awaiting realization under the magic touch of the skilled engineer. The public is not wholly to blame. The engineer is to a certain extent culpable. He has not fully felt the need of diffusion of information, except among his professional brothers. He has not taken the public into his confidence and explained in simple terms, in ways that would attract the public, the results already achieved; nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work affects him or how his condition may be improved.

Engineers in North America Number 100,000

It is safe to assume that there are in North America over 100,000 men whom we would class as "engineers" outside of the purely mechanical occupations. Of these over 40,000 are members of approximately 100 organizations,[1] leaving over 60,000 men not enrolled in any engineering society.

In the great group of 60,000 are many men of ability and standing in the profession, but who have never seen the necessity of joining with their fellows in organized efforts. By far the greater part, however, are the younger or less prosperous men, who are performing routine work in engineering offices or engaged in the details of the country surveyor and engineer. As a whole, they include the more poorly paid professional men whose compensation averages less probably than that of the high-grade mechanics. We do not have any definite data on this point, but those who have employed engineers and graduates of engineering schools are aware of the fact that under present conditions at least, we can obtain the service of highly educated skilled engineers as computers, draftsmen, office or field assistants at a nominal wage.

It is not the "submerged tenth" but the six-tenths for whom special appeal should be made to ascertain whether their condition may not be improved by applying to it the same painstaking study to ascertain the facts and to provide a remedy, as should be done by the engineer to meet and overcome physical obstacles.

Widening the Field for Engineers' Work

To this large body of engineers there is being added each year about 5,000 recruits, mainly from the engineering colleges, more or less well-trained in the fundamentals of engineering. One of the problems that is now confronting us is the fact that each year this large group of graduates, as well as the thousands of young men employed in engineering offices, is coming into a profession apparently overcrowded. This overcrowding, however, is more apparent than real. A relief is to be obtained not by limiting the influx of men, but rather by widening the field of service.

The field is practically unlimited, the bounds extending with every improvement in the conditions favorable to human health, comfort and industry. Artificial limits, the cramping efforts of which we now appreciate, are set solely by ignorance. They exist only in the mind and arise because of lack of knowledge by the public in general and of individuals in particular. To put it in another way, if every taxpayer and voter in the country, every town, city, county and state officer, were fully aware of the conditions which surround him and the extent to which the engineer could remedy or improve these conditions, there would be an immediate demand for all the engineers that could be found.

To seize properly the opportunity the engineer who rises to the occasion must cultivate some of the qualities summed up in the term *salesmanship*. We recognize that the success of many a merchant is due to a peculiar art that he has acquired and one that enables him to sell goods at a profit. We have more slowly come to recognize the fact that his success is due not to the fact that he personally makes a profit, but that the other party, the world to whom he sells, is benefited. For a time a merchant may sell inferior goods and make money, but an established business can rest secure only on honest advertising and on the realization by the public that he is performing a real service to mankind.

In the same way, the engineer, to succeed, must acquire the art of salesmanship. He may not recognize or label the quality and may even deny its existence. He may point to a code of ethics rigidly observed against advertising or self-exploitation, and yet he may possess to a high degree the real art of presenting his ware in such a way as to convince the world that its general welfare is promoted by purchasing from him.

There is perhaps nothing more instructive to the young engineer than to try to ascertain the methods of salesmanship which have led to the recognition of certain well-known and respected engineers. Some have succeeded through or in spite of extreme modesty; but in each case there has been not only true value of the goods to be delivered, but some quality of mind or action that has impressed upon others the fact that the goods are of superior value.

Line of Action for Awakened Engineers

In the present awakening of engineers innumerable schemes have been suggested for action, but most of these fall under one or the other of two principal lines: (1) Coördination and coöperation of existing engineering societies and organizations; (2) formation of one or more new associations devoted almost exclusively to the material welfare of engineers. These movements are the natural outgrowth of the discussion and unrest which have prevailed. They are not antagonistic and may be mutually helpful. Not all men think alike, and the path which will be attractive to one group is not to another.

[1] The larger part of this 40,000 is included in four great national societies, the membership of which in round numbers is as follows: Civil, 7,700; Mechanical, 6,100; Mining, 5,000; Electrical, 7,750. The total of 26,550 includes many duplications, but it is safe to assume that at least 20,000 engineers, embracing most of the men who have become leaders in the profession, are included in the membership noted. The organizations next in point of size are the Engineers' Society of Western Pennsylvania, with headquarters at Pittsburgh, 1,150 members; and the Western Society of Engineers, with office in Chicago, 1,200 members; next the Associated Engineering Society of St. Louis, with 800. The hundred or more local engineering societies organized at the principal centers of population have a membership each of from 100 or less up to 500 or more, averaging about 200.

In establishing a new movement or society the burden of proof of the need of such organization is upon the promoters. If it is proposed to assume new costs and create new obligations, it must be clearly shown that there exists not only real need for this additional machinery, but that the public will be the gainer thereby.

If we go deeply, we find that in a free country no volunteer organization can long exist if it be founded on purely selfish motives. The public does not long deal with the merchant that does not give fair bargains, and it does not look with favor upon any body of men brought together for confessedly selfish ends. If, therefore, any movement should be so unfortunate as to start with the handicap of popular misconception that it is devoted solely to the financial gain of its members, its future history would likely be short and stormy. For this reason the benefits kept prominently in view should be those, not of individuals, but of society as a whole.

Summing up the needs and opportunities, it appears that a great part of the main body of engineers is not fully employed to the best advantages to society and to themselves, with corresponding loss to all. Nearly two-thirds of those who may properly call themselves engineers, or perhaps 60,000 men, are not members of any well-recognized organization, and are not utilizing their potential strength to help themselves or one another. There is need of enlightenment, of raising ideals and of united effort toward better things. The existing engineering organizations, which include perhaps 40,000 men, are devoted almost exclusively to technical questions as distinct from those things that concern the engineer as an individual and a citizen. Few of the older societies attempt to bring in the rank and file of the profession, or attempt to cover the field of the new American Association of Engineers in its efforts to help and reach the masses of the profession.

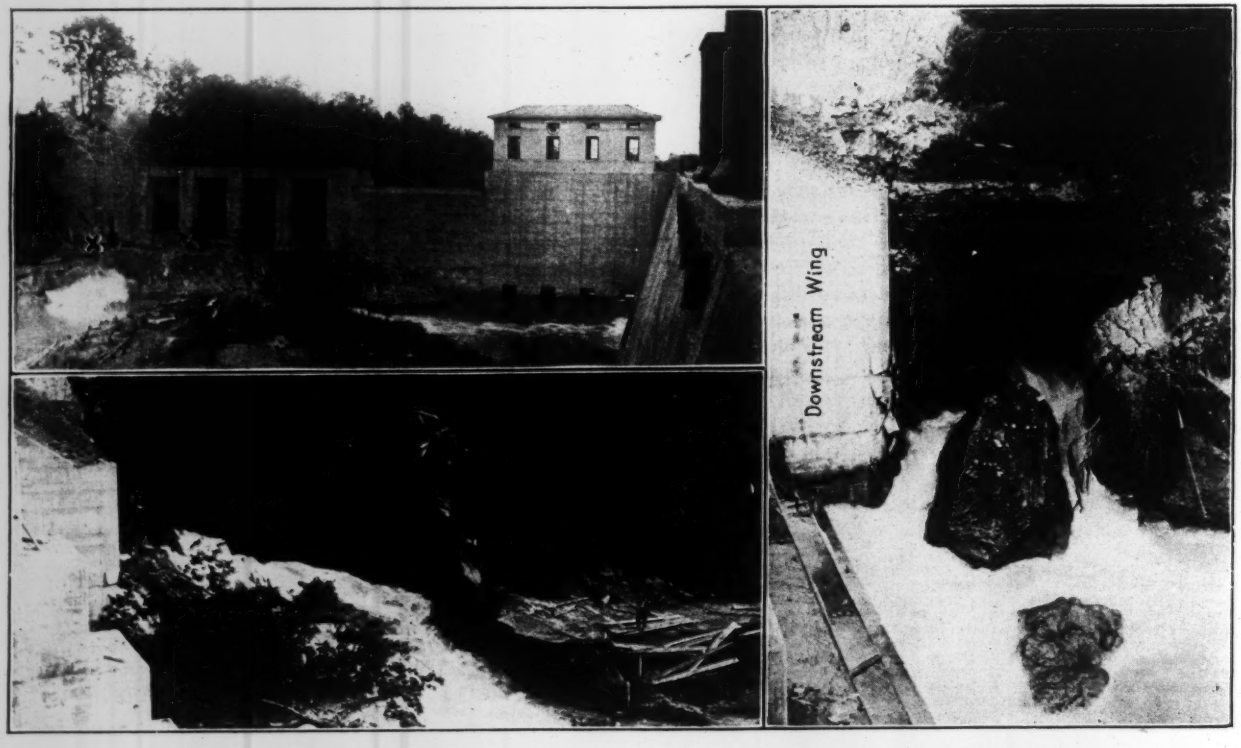
News of the Engineering World

Blowout at End of Concrete Dam, Seneca Falls, N. Y.*

A partial failure of dam No. 2 on the Cayuga & Seneca Canal, about a mile below the village of Seneca Falls, N. Y., occurred Sept. 3. The failure was caused by leakage around the end of one abutment and cutoff wall. This dam is part of the New York State Barge Canal system, and was built to mantain a 4-mi. level to Waterloo.

The dam is about 475 ft. long and is made up of an earth-filled section on the south end, a pair of twin locks in the center and a solid concrete section on the north end. The part of the canal immediately above the dam spreads out and forms an artificial lake 1,500 ft. wide.

*Information furnished by Reed W. Cady, Civil Engineer, Seneca Falls, N. Y.



BLOWOUT AT END OF CONCRETE DAM, CAYUGA & SENECA CANAL, SENECA FALLS, N. Y.
Cross in upper left-hand view shows upstream end of blowout; other views show downstream end

The break occurred at the north end of the concrete part of the dam, where the original surface was an abrupt outcrop of soft shale with occasional strata of a harder, somewhat porous rock. A cutoff wall was carried into this bank 50 ft. from the original surface, which at the time was thought sufficient, although the porous nature of the material was known.

The dam was completed and the canal level filled on Aug. 19 and 20 of this year. Seepage was noticed at once on the downstream side of the slope, but the water that came through was clear. The flow was equivalent to that from a 4-in. orifice, and apparently did not increase during the first ten days.

On Sept. 2 it was noticed that the rocks were wet for over 100 ft. downstream and that the leakage was slightly more. At 7 a.m. on the 3rd a big stream was noticed rushing from the hole just below the abutment. Responsible people were notified at once, and the boats on the canal level above were warned.

To facilitate drawing off the water the valves of the lock were opened, and by 6 p.m. of that day the head was reduced 12 ft. Some 36 hr. after the break the hole was exposed. The water had eroded a tunnel 120 ft. long around the end of the cutoff wall. This blowout varied in size from 6x8 ft. near the inlet to 12x20 ft. at the outlet. The opening on the upstream side was 30 ft. and at the outlet was 45 ft. below the original pool level. No injury was done to the dam masonry, for all the water found its way around the end and not under the concrete. Large quantities of earth and soft rock were washed from below and behind the abutment.

Plans for repairs have not been decided upon, but they will probably include building the cutoff wall farther into the hill, blanketing the upstream slope with a clay embankment or grouting the porous strata.

San Francisco Shore Protection

The design for the protection of the ocean beach alongside the new esplanade in San Francisco has just been completed, and it is announced that bids for one unit will be called for in a few weeks. As described on page 499 (Sept. 9, 1915) the esplanade is a new boulevard on the Pacific-coast side of San Francisco. In its preparation it is necessary to protect the beach against the inroads of the sea, and the wall and paving shown in the accompanying drawings are intended for that purpose.

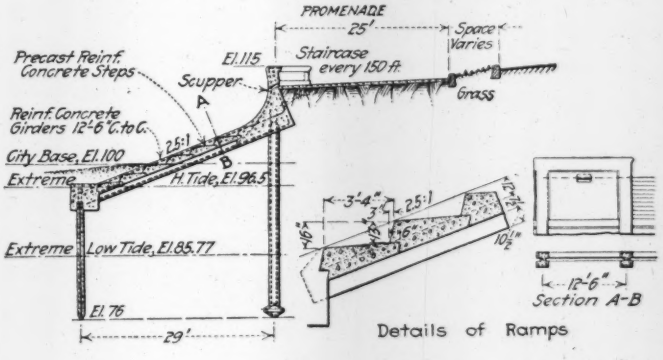


FIG. 1. DETAILS OF SEAWALL AT ESPLANADE

The beach protection consists of a series of steps six in number, which will be erected from beneath the surface of the sands to a position well above the influence of ordinary breakers. Backing the steps is a seawall of reinforced concrete with a front molded to a curve that will throw the breakers back upon themselves and thus counteract their destructive force. Every 150 ft. along the breakwater a concrete stairway will lead from the beach to the scenic boulevard, or esplanade, which will parallel the steps on the east. In front of the steps reinforced-concrete interlocking sheetpiles will be driven 15 ft. below mean tide, as a protection against the underscour of the seas, and as a foundation for the reinforced-concrete seawall, pedestral piles with mushroom bottoms will be driven at intervals of 10 ft.

Between the coping and the Great Highway, or esplanade proper, will be a promenade 25 ft. in width, of artificial stone. This will be built on a slight slope draining toward the parapet wall, through which will be scupper holes to release any water from wave crests which may top the parapet.

The price estimated for the construction of the first section, to be constructed along the beach for a distance of 650 ft. southward from a point near the terminus of Cabrillo St., is about $48,500. The design and construction are under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

Activated-Sludge Progress at Cleveland, Ohio

Plans for a 1,000,000-gal. unit of activated-sludge tanks have been completed for Cleveland, Ohio, under the direction of R. Winthrop Pratt, consulting engineer. The plans have been so drawn that this unit could, with moderate changes, be made a part of the Imhoff sewage-treatment scheme already tentatively adopted for the east-side disposal works at Cleveland. Bids for the work were to be received on Sept. 15.

The small experimental activated-sludge tank at Cleveland, described in the review of activated-sludge experiments in *Engineering News* for July 15, 1915, is giving good results. The effluent from this tank after three hours aëration and ten or fifteen minutes sedimentation is bright and clear; in fact, it compares very favorably in appearance with the city water-supply.

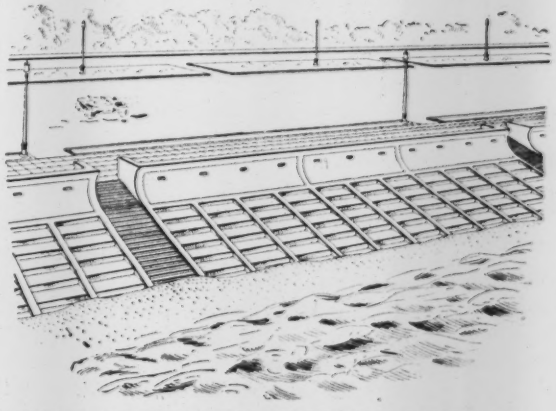


FIG. 2. PERSPECTIVE OF SHORE PROTECTION

Status of the Bronze Troubles on the Catskill Aqueduct

Rumors about new and greater troubles with cracking of bronze on the Catskill Aqueduct, New York City, are answered by Alfred D. Flinn, Deputy Chief Engineer, as follows:

Information on the subject up to about six months ago has already appeared.[1] For certain bolts, ladders, pipe fittings, valves and similar parts which would be exposed to moisture and difficult of replacement, the engineers of the Board of Water Supply sought a material highly resistant to corrosion and of sufficient strength to replace cast iron and steel, commonly used for such purposes. After careful inquiry, manganese bronze, Tobin bronze and naval brass were adopted. In the course of time some bolts were found cracked, and as time progressed this trouble with rolled and drawn material proved to be so extensive as to require replacement in a great many instances. The large forgings, principally for valve and sluice-gate stems, have developed no defects. Most of the castings have continued to be sound.

Recently, however, a number of castings, especially parts of large bronze gate valves, have developed fine cracks. Apparently these cracks result from repairs of foundry defects made by the process of "burning in," or welding, which has long been practiced in most if not all brass foundries. These valves are in chambers near the surface of the ground, where they are accessible for removal, for replacement or for such repairs as may be decided upon. The trouble mentioned is annoying, but will not delay the introduction of Catskill water beyond the time expected, the fall of 1916.

N. Y. Fire Department Reports on Subway Dangers

As a result of the serious fire in the New York subway on Jan. 6, 1915 (noted in *Engineering News*, Jan. 14, 1915), and at the request of the mayor, a study of the New York subway from the standpoint of the fire department was made by John Kenlon, Putnam A. Bates and Joseph O. Hammitt, all of the department. After an extended investigation they have recommended the following measures, as needed fire-prevention work: The substitution of steel cars for wood; isolation of buildings and show windows from the subway by fire walls; installation of electric wiring in fireproof conduits; use of slow-burning wood for third-rail guards; use of metal news-stands, doors, lockers, etc., in the stations; improvement of general house-keeping conditions in workshops and locker rooms; reduction and safeguarding of the storage and use of inflammable liquids; complete isolation of the various electric-wiring systems from one another to prevent communication of a breakdown; installation of emergency lights along the subway; duplication of current supply for lighting; installation of a complete fire-alarm system of approved construction, connecting with fire headquarters; installation of a complete additional telephone system connecting the power plant and executive offices of the operating company with stations every 500 ft. throughout the subway; reconstruction of splicing chambers to segregate wiring systems and to prevent escape of smoke or gases into the subway; better upkeep of emergency battery lamps in cars and equipment of each car with portable electric lamps; division of the subway by longitudinal walls between tracks, with protected openings at 500-ft. intervals; additional and improved emergency exits to the street; training of operating employees in regard to procedure in case of fire.

[1]See "Engineering News," Nov. 26, 1914, p. 1092, "Unsatisfactory Performance of Brass and Bronze on the Catskill Aqueduct," stating the nature and extent of the cracking; and July 8, 1915, p. 69, "Cracking of Copper Alloys," which discusses the vital relation of corrosion to the phenomenon.

City of Philadelphia Starts Rapid-Transit Work

Extension of Philadelphia's one subway line (Market St.) into a large municipal rapid-transit network began last week with the start of work on subway and elevated contracts awarded in August. Bids are also asked for another section of elevated, to be opened Oct. 19. Henry H. Quimby, Chief Engineer of the Department of City Transit,[1] gives the following statement:

The subway contract covers the City Hall Station section of the Broad St. line, extending from Filbert St. to South Penn Sq., about 750 ft. long, passing under the present subway line in Filbert St. and in South Penn Sq., and passing also under City Hall diagonally, with four tracks and two island platforms, and including galleries, entrance stairs, escalator wells, ventilation, drainage, etc.

The elevated contract covers the column foundations and piers for about 5 mi. of line from Front and Callowhill St. to Frankford Ave. and Unity St.

The work embraced in these contracts and in the ones that will follow shortly to complete the construction of the first five miles of the Frankford Elevated was authorized by ordinance of Councils July 2, 1915, to be paid for out of an initial loan of $6,000,000, approved for the purpose by the voters of the city at a special election held Apr. 29, 1915, and apportioned by Councils equally between the subway and the elevated.

The initial loan was limited to this amount because of the expectation of the adoption by the electors of the state at the November election of a constitutional amendment, which has already been passed by the Legislature and now requires only the approval of the voters, and which, if so approved, will not only extend the borrowing capacity of the city, but will permit the borrowing to be done upon longer-term bonds, and the funding of interest and sinking-fund charges during construction, and the grading of the sinking-fund payments so that in the early years of operation they will be light and in the later years of their term they will be heavier to make up the amortizing amount.

As soon as the municipal legislation authorizing the work was enacted, the construction plans were submitted to the Public Service Commission of Pennsylvania for approval and for a certificate of public convenience, which is by law required to be obtained from the commission before any new lines or extensions of lines are constructed. The certificate was granted and the plans approved Aug. 14. A taxpayer's suit was brought July 10, to restrain the department from proceeding with the work, but after the decision of the Public Service Commission the suit was

[1]754 Bourse Building, Philadelphia, Penn.

withdrawn. The contracts were then immediately awarded.

Bids are now being invited, to be opened Oct. 19, for the steel superstructure of the 5-mi. stretch of the Frankford Elevated, and contracts will follow for the concrete floor and for the station platforms, buildings and stairs.

Additional sections of subway will be advertised soon. The one now under way was made the first because it involves the most difficult and tedious work and will require the longest time to complete, there being about 3,000 ft. of heavy and thick walls to underpin besides the two lines of existing subway structure.

Additional sections of elevated will be advertised as soon as the south terminus of the line is determined, this portion of the route being dependent upon the outcome of negotiations for the operation of the lines. If a satisfactory contract shall be made with the trolley company, which also owns the Market St. rapid-transit line, the Frankford Elevated will be connected to the Market St. line at Front and Arch St. Construction plans for this route are complete, and it is expected that if there shall be no delay in the program the Frankford line can be completed for operation early in 1917.

Preliminary construction work on the subway system has been in progress since Mar. 20, 1915, when the relocation and reconstruction of sewers were commenced. Six contracts were placed for this advance work, involving about $450,000, and three of them have been completed.

The plans of the Department of City Transit, which was organized under authority of special state legislation to have supervision and control of the transit facilities of the city and is presided over by Director A. Merritt Taylor, contemplate the immediate construction of about 11 mi. of subway north and south in Broad St. (half four-track and half two-track), with elevated spurs to the east and the west at the north, together with a double-track elevated railway 7 mi. long to the Frankford district of the city, nearly paralleling the Delaware River, and probably making a connection with the present Market St. subway for operation through the central business district; estimated cost of structure $34,000,000.

The plans cover also a 6-mi. double-track elevated railway southwestward to the Darby district, to be built immediately after the completion of the Frankford line and to connect provisionally with the Market St. line at 30th St.; estimated cost of construction $4,500,000. Also, later, a double-track subway under the Parkway connecting with the Broad St. subway at City Hall, emerging in Fairmont Park and extending as an elevated along 29th St. and Henry Ave. to the Roxborough district, 8 mi. Also, as traffic will make necessary, a 1½-mi. delivery loop for the Broad St. subway in the central business district.

Studies and tentative plans have been made for a subway under Chestnut St. through the central business district and connecting the Frankford and Darby lines when traffic in the Market St. subway shall have reached the limit of the capacity of that line.

U. S. Naval Advisory Board

The personnel of the Naval Advisory Board of Inventions appointed by Josephus Daniels, Secretary of the Navy, has been already announced piecemeal in the personal columns of *Engineering News*. The complete board consists of 23 members; the chairman and original appointee is Thomas A. Edison. The other 22 members were chosen (in most cases by the governing boards) by the eleven principal engineering and scientific societies, and their formal appointment by Secretary Daniels has just been announced. These appointees are listed below according to the society they represent:

American Society of Civil Engineers—Andrew Murray Hunt, Consulting Engineer, of San Francisco, Calif., is a native of Sioux City, Iowa, and a graduate (1875) of the United States Naval Academy. His engineering activities include hydro-electric and irrigation developments, steam-power and gas plants, oil refineries, cement-manufacturing plants and other industrial works. Alfred Craven, Chief Engineer of the Public Service Commission, First District, New York, is a native of New Jersey and was graduated from the United States Naval Academy in 1867. A biographical sketch of Mr. Craven was published in *Engineering News* Oct. 8, 1914.

American Society of Mechanical Engineers—William Le Roy Emmet was born in New York State and is a graduate (1881) of the United States Naval Academy. He designed and directed the development of the Curtis steam turbine by the General Electric Co. and has done much in the field of electric power for ship propulsion, as well as other electrical engineering work. Spencer Miller was born in Illinois and was graduated from Worcester Polytechnic Institute in 1879. He is Chief Engineer of the Lidgerwood Manufacturing Co., New York City, and is noted for his cableway inventions, particularly the adaptation of this device to coaling ships at sea.

American Institute of Electrical Engineers—Frank Julian Sprague, a native of Connecticut and a graduate of the United States Naval Academy (1878), is the founder of the Sprague Electric Co. and an electrical engineer of international reputation. B. G. Lamme was born in Springfield, Ohio, and was graduated from Ohio State University in 1888. He has designed much electrical machinery and is now Chief Engineer of the Westinghouse Electric and Manufacturing Co.

American Institute of Mining Engineers—William Lawrence Sanders was graduated from Pennsylvania University in 1876. He is Chairman of the Board of Directors of the Ingersoll-Rand Co. and the inventor of many improvements to drilling machinery. Benjamin Bowditch Thayer was born in San Francisco and was graduated from Harvard University in 1885. He is a noted mining engineer and is President of the Anaconda Copper Mining Co.

The Inventors' Guild—Peter Cooper Hewitt, of New York, and Thomas Robins, President of the Robins Conveying Belt Co., Passaic, N. J.

American Society of Automobile Engineers—Andrew L. Riker, of Detroit, and Howard E. Coffin, Vice-President of the Hudson Motor Car Co., Detroit, who was educated at the University of Michigan.

American Society of Aeronautic Engineers—Henry A. W. Wood, New York City, and Elmer Ambrose Sperry, New York City, a graduate of Cornell University.

American Electro-Chemical Society—Joseph William Richards, South Bethlehem, Penn., a graduate of Lehigh University, and Lawrence Addicks, who was graduated from the Massachusetts Institute of Technology in 1889, Consulting Engineer of Phelps, Dodge & Co., New York City.

American Chemical Society—W. R. Whitney, Director of the Research Laboratory of the General Electric Co., Schenectady, N. Y., is a graduate of Massachusetts Institute of Technology (1890). L. H. Backeland is a Belgian and a graduate of the University of Ghent and is famous as the inventor of "Velox" photographic paper and of "Bakelite," an insulating material.

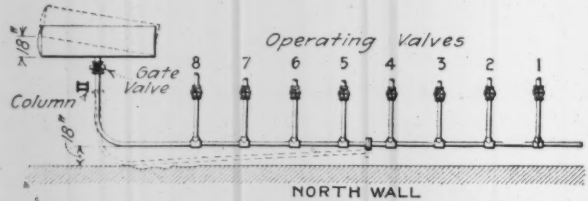
American Aeronautical Society—Matthew Bacon Sellers, Baltimore, Md., a graduate of Harvard University, and Hudson Maxim, of Brooklyn, N. Y.

American Mathematical Society—Robert Simpson Woodward, Washington, D. C., a graduate of Michigan University, President of the Carnegie Institution, and Arthur Gordon Webster, a Harvard graduate, Professor of Physics at Clark University, Worcester, Mass.

Hydraulic Elevators Shut Down by Broken Gate Valve*

Seven of the eight hydraulic elevators in the Bowling Green Building, New York City, sank to the bottom when a 14-in. gate valve in the main line from the high-pressure water-storage tanks to the elevator-machine cylinders broke, at noon on Sept. 3. The other elevator was at the bottom already and therefore did not participate in the accident.

The accompanying diagram indicates what took place when the valve casing broke. The high-pressure water was contained in two cylindrical tanks, one above the other



SUPPLY LINES FOR BOWLING GREEN ELEVATORS

and connected by a pipe. The lower tank was kept full, the upper nearly so except for the air at the top, under 180 lb. pressure. The storage water was of course released. The tanks were thrown out of place horizontally about 18 in., and the pipe line was thrown out in the opposite direction about the same distance, being stopped by the north wall of the building. The valve was further damaged by striking the column shown in the diagram.

When the valve broke, the operating valves in the elevator cars closed immediately, allowing the escape of only a gallon or two of water from each of the vertical cylinders in the shaft. All the cars descended at not more than normal speed until they were within a few inches of the bottom, when the effect of the slight leakage was felt and the cars dropped with a bump. None of the 30 passengers was injured.

About half the main pipe line was practically undamaged, as indicated in the diagram. The four elevators on this portion of the line were speedily put in operation, power being furnished by the low-pressure (120 lb.) supply.

Levee Flood Gates Were Carried Out in East St. Louis last week during a fall of the Mississippi River. These backwater gates (on Cahokia Creek) are reported to have been built for temporary use by the East Side Levee and Sanitary District in 1912, and this outlet would eventually have been abandoned. The old creek channel stood full and the gates were clogged.

*Noted in "Engineering News," Sept. 9.

The Retaining Walls for the Levee of the Kaw River Drainage District, Kansas City, Kan. (see "Engineering News," Aug. 26, 1915, p. 430), are to be redesigned before construction.

The Injunction in the Minneapolis Water-Filter-Patent Suit (Ira H. Jewell vs. City of Minneapolis; see "Engineering News," Sept. 9, 1915, p. 523) has been suspended until a decision is reached in an appeal to the United States Circuit Court of Appeals.

PERSONALS

Capt. Harold C. Fiske, Corps of Engineers, U. S. A., has been relieved from duty at Pittsburgh, Penn., and will be stationed at Vicksburg, Miss.

Maj. Elliott J. Dent, Assoc. M. Am. Soc. C. E., Corps of Engineers, U. S. A., has been relieved from duty in New York City and will be stationed at Little Rock, Ark.

Mr. James P. Nelson, a member of the Valuation Committee of the Chesapeake & Ohio Ry. Co., has been placed in charge of the engineering work of the committee.

Mr. Fred W. Cummings, Superintendent of the municipal garbage-reduction plant of Cleveland, Ohio, resigned on Aug. 31 to accept a position with a similar plant operated by a private company at Detroit, Mich.

Mr. E. S. Mudge, Division Engineer of the Atchison, Topeka & Santa Fé Ry. at Wellington, Kan., has been made Assistant Engineer in Charge of Valuation for the Western lines of the road, wtih headquarters at Amarillo, Texas.

Mr. W. P. Danford, formerly City Engineer of Durant, Okla., has been appointed Assistant State Engineer of the State Highway Department, with headquarters at Oklahoma City. He will act as State Engineer until Oct. 1.

Mr. P. J. Flynn, Manager of the Winnipeg Union Terminals, has been appointed Superintendent of the Canadian Northern Ry., with headquarters at Winnipeg, Man. He succeeds Mr. M. B. Murphy, who has been transferred to Calgary, Alta.

Mr. W. D. Pearce, Assistant Engineer of the Northern Pacific Ry., has been appointed Supervisor of Bridges and Buildings on the Yellowstone division, with headquarters at Glendive, Mont. He succeeds Mr. W. C. Sloan, who has been promoted.

Mr. Frank C. French, M. Am. Soc. C. E., who for several years past has been connected with the Butte & Superior Copper Co. and other copper properties in the Butte district, will reopen offices in Salt Lake City for the practice of civil and mining engineering.

Mr. R. D. Starbuck, Special Engineer on the staff of Mr. J. J. Bernet, Vice-President of the New York Central & Hudson River R.R., at Chicago, has been transferred as Special Engineer on the staff of Mr. A. T. Hardin, Assoc. M. Am. Soc. C. E., Vice-President in Charge of Operation, at New York City.

Mr. Julius Edgar Willoughby, M. Am. Soc. C. E., Assistant Chief Engineer of the Atlantic Coast Line, has been made Chief Engineer, with headquarters at Wilmington, N. C., to succeed the late E. B. Pleasants. Mr. Willoughby entered the service of the Atlantic Coast Line as Assistant Chief Engineer in 1913, which position he has held until his present appointment.

Mr. John G. D. Mack, M. Am. Soc. M. E., Professor of Machine Design in the College of Engineering, University of Wisconsin, has been appointed State Chief Engineer by the Railroad Commission of Wisconsin, with a salary of $6,000 a year. Professor Mack will have charge of and supervision over all engineering work for the state, including the engineering work of the Railroad, Highway and Tax Commissions. He has been a member of the University Faculty for nearly 25 years.

OBITUARY

William F. Endress, Captain, Corps of Engineers, U. S. A., died Sept. 7 from pneumonia while on board the steamer "Allianca" en route from Colon to New York.

John Haines Warder, Assoc. Am. Soc. C. E., whose death was noted in "Engineering News" of Sept. 9, became Secretary of the Western Society of Engineers in January, 1901,

which position he held until his death. He resigned as Assistant Engineer of the Bureau of Sewers of Chicago to accept the position of Secretary of the society.

Edward B. Moore, ex-United States Commissioner of Patents, died Sept. 7 at his home in Washington, D. C. Mr. Moore was born at North Anson, Me., in 1851. After receiving a high-school education he became a page in the United States Senate. In 1881 he was admitted to the bar and in 1883 became an assistant examiner in the Patent Office, with which he was connected for 30 years. He was Commissioner from 1907 to 1913, at which time he left the Patent Office to become a member of the law firm of Moore & Clark in Washington.

Dr. Karl E. Guthe, Dean of the Graduate Department, University of Michigan, died at Ashland, Ore., on Sept. 11. Dr. Guthe was born in Hanover, Germany, in 1866, and received his education in the Hanover Technical School and the Universities of Marburg, Strassburg and Berlin. He came to the United States in 1892 and entered the University of Michigan as an instructor in physics, being made Assistant Professor in 1900. In 1903 he was appointed Associate Physicist in the United States Bureau of Standards, and in 1905 was Professor of Physics in the Iowa State University. The same year he was made Professor of Physics at the University of Michigan. In 1909 he became Dean. Dr. Guthe was the author of several books on physics and a member of the Bureau of Awards of the St. Louis Exposition.

Sir William C. Van Horne, K. C. M. G., Assoc. Can. Soc. C. E., a noted railroad builder and financier of Canada, died at the Royal Victoria Hospital in Montreal, Sept. 11. Sir William was born in Will County, Ill., in 1843, and at the age of 13 was left upon his own resources. He worked in the railroad yards and afterward as a telegraph operator with the Illinois Central R.R., after rapid strides becoming General Superintendent of the St. Louis, Kansas City & Northern Ry. Later he was connected with the Southern Minnesota Ry. as General Manager and the Chicago & Alton R.R. and the Chicago, Milwaukee & St. Paul Ry. as General Superintendent. In 1882 he moved to Canada and became General Manager of the Canadian Pacific Ry. and superintended its extension to the Pacific Coast. Sir William was Vice-President of the road from 1884 to 1888, President from 1888 to 1899 and was made Chairman of the Board of Directors the following year. He was knighted by Queen Victoria in 1894 in recognition of his railway work in Canada and for his interest and services in public affairs.

Dr. John E. Sinclair, Professor Emeritus of Mathematics at the Worcester Polytechnic Institute, died Sept. 12 at his home in Worcester, Mass. He was born at Brentwood, N. H., Mar. 28, 1838, and was graduated from Dartmouth College in 1858. He began teaching at Adrian, Mich., the same year, and from 1859 to 1863 he was an instructor at Washington University, St. Louis, Mo., where the honorary degree of A.M. was conferred upon him in 1862. From 1863 to 1869 he was Assistant Professor and Professor of Mathematics at Dartmouth. He was made Professor of Mathematics at Worcester Polytechnic Institute at the inception of the school in 1869 and was head of the mathematics department until 1908. Practically every graduate of the Institute up to that year passed through his hands in "calc. and analyt.," and no professor was ever more original in his methods of instruction or more dearly loved than "Johnny Sin²," as he was affectionately called by generations of Worcester men. Dr. Sinclair was retired on a well-earned pension in 1907. At the recent semi-centennial anniversary of the Institute he was an honored guest.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Pan-American Road Congress—The Pan-American Road Congress is scheduled to be held all next week in Oakland, under the joint auspices of the American Road Builders' Association and the American Highway Association. Other road associations holding their conventions on the same dates are the Tri-State Good Roads Association and the Pacific Highway Association.

Engineers' Society of Pennsylvania—On Sept. 17-18, members of the society intend to make an inspection trip to Torresdale, where a filtration plant and experimental sewage-disposal plant are situated. The party will then go by special boat down the Delaware River, viewing the harbor improvements and visiting League Island Navy Yard and the New York Shipbuilding plant. Theater parties are planned for the evening of the 17th. The next morning the party will go by automobile to the Baldwin Locomotive Works and in the afternoon to a ball game. The Secretary is E. R. Dasher, 31 South Front St., Harrisburg, Penn.

American Society for Municipal Improvement—The 22nd annual convention will be held in Dayton, Ohio, Oct. 12-15, at the Hotel Miami. Proof sheets of the program have just been received in this office, indicating that the program of the convention will soon be issued to the membership. A banquet will be tendered by the National Paving Brick Manufacturers' Association on Oct. 12. The entertainment of the ladies is in charge of the Dayton Engineers' Club, and the program for the week has been arranged. The secretary of the Municipal Improvement Society is Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

"The Smoke Prevention Association"—At the tenth annual convention of the International Association for the Prevention of Smoke, held in Cincinnati, Sept. 8 to 10, the name of the society was changed to the Smoke Prevention Association. The 1916 convention will be held in St. Louis. Prof. J. J. O'Connor, of the Mellon Institute of Industrial Research, University of Pittsburgh, stated that Pittsburgh intends to hold a large exhibition of smoke-prevention appliances in 1917 and wants the convention there that year. Officers were elected as follows: President, William A. Hoffman, St. Louis; Vice-President, Charles W. Heath, Cincinnati; Secretary-Treasurer, Frank Chambers, Chicago.

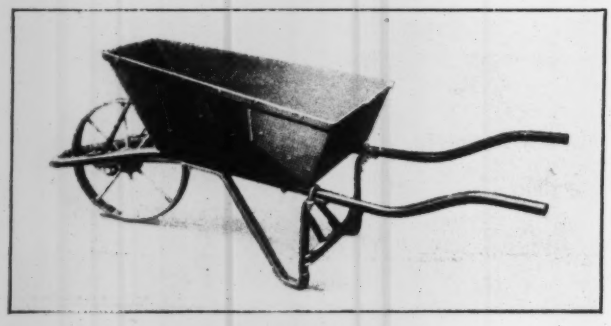
American Public Health Association—The annual convention held at Rochester, N. Y., Sept. 7-10, was one of the largest and most successful in the history of the association. Many papers were presented before the association as a whole and before the half-dozen sections. Dr. John F. Anderson, Di-

rector Hygienic Laboratory, United States Public Health Service, was elected President, to succeed Prof. William T. Sedgwick, of the Massachusetts Institute of Technology, and Prof. Selskar M. Gunn, 755 Boylston St., Boston, Mass., was reëlected as Secretary. Prof. George C. Whipple, of Harvard University, was elected Chairman, and Theodore Horton, Chief Engineer of the New York State Department of Health, was made Vice-Chairman of the Sanitary Engineering Section. The 1916 convention will be held at Cincinnati.

Appliances and Materials

Contractor's Measuring Wheelbarrow

The barrow shown in the accompanying illustration has been developed by the Sterling Wheelbarrow Co., of West Allis, Wis., in response to the demands of contractors laying concrete sidewalks, bases for asphalt and wood-block pavements, etc. The demands of most municipalities where such



CONTRACTOR'S MEASURING BARROW

work is being done are for careful measuring of ingredients and material placed, and on the majority of these jobs a barrow of known capacity is the most convenient measure. This wheelbarrow is regularly furnished in 2- and 3-cu.ft. sizes.

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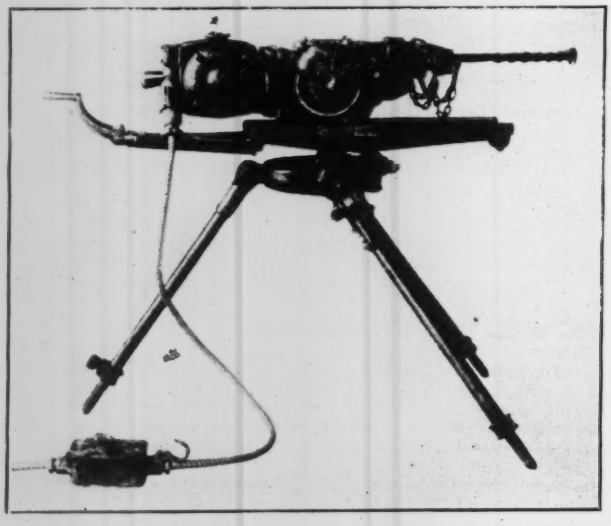
Electric Percussion Rock Drills

After making trial installations of an electric rock drill for several years, the Fort Wayne (Ind.) Electric Works have standardized their line for regular production. The drill, as shown in the accompanying views, is of a rotary-hammer type



SIDE AND PHANTOM VIEWS OF FORT WAYNE ELECTRIC PERCUSSION ROCK DRILL

for mounting on tripod, column or bar. A rotating helve carries two hammers and is belt-driven (850 r.p.m.) by the driving motor, using a tightening idler pulley to give speed variation. A round-headed hammer strikes a round-headed cap or tappet block against which the drill steel is set. On the recoil the hammers are cushioned by the air trapped in the hammer chambers. Normally, the drill gets 1700 blows per min. Around the steel is also a sleeve gripping it and itself rotated by a worm gear on the helve shaft. Spring-steel plates hold the drill steel in the chuck and absorb the energy of the blows when the steel is not in rock. Special drills are used with a helical rib, or wing, going around from point to grip and serving to convey the rock punchings out of the drill hole. The motor has ball bearings; the other rotating parts are mounted in roller bearings. All are packed in grease and require attention only about once in 30 days. The motors are fully inclosed and designed for use in wet places; they are furnished for 115, 230 and 550 volts, direct current, and 110 and 220 volts, single- or two-phase alternating current. From 1.5 to 2.5 hp. generator capacity is needed per drill.

The machines now put out (A 10) are medium-capacity drills making holes up to about 12 ft. deep and finishing at 1½-in. bottom diameter. The body and shell weigh 275 lb., the motor 130 to 175 lb., the tripod 175 lb. This drill has a capacity equal to a 2½- or 3-in. piston drill which may require 12 to 18 hp. in compressors.

Electric drills are finding increasing use owing to their greater convenience and the saved investment in compressor, engine or motor, and piping—besides showing decreased maintenance and operating labor. Among the notable uses of these drills should be mentioned the Sun River irrigation project of the United States Reclamation Service (all machinery here driven by electricity as noted in "Engineering News," Oct. 29, 1914), and the Canadian Northern tunnel, near Duluth, Minn. The Rochester (N. Y.) Railway and Light Co. during the past three years has purchased several electric rock drills, which are rented to contractors doing work near the power lines.

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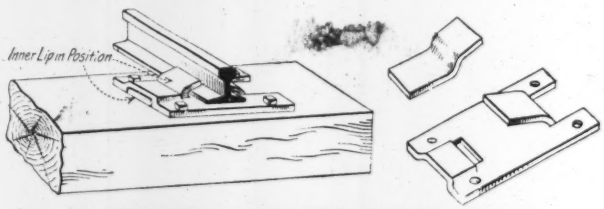
Improved Two-Piece Rail Chair

An improved design of two-piece rail chair, to be used with driven or screwed spikes or bolt fasteners, is shown in



TWO-PIECE GRIPPING RAIL CHAIR

the accompanying sketch. The inner lip gives a strong grip on the rail base. The device is made by the American Rail Chair Co., Ewing Building, Findlay, Ohio.

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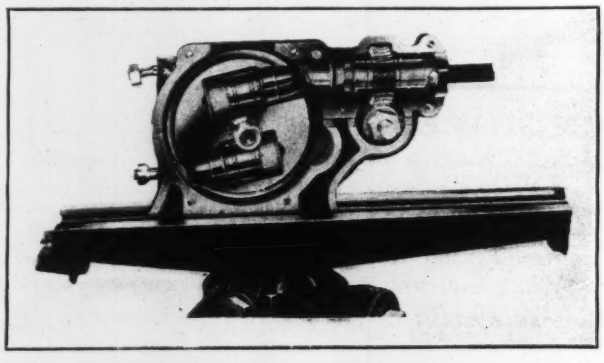
One-Bag Low-Level Concrete Mixer

A new mixer (Rex No. 10) has been added to the line of the Chain Belt Co., of Milwaukee, Wis. This has a capacity of 10 cu.ft. and is assembled on a low truck for ease in charging, the platform (when used in place of a charging hopper) being 22 in. above the ground. The construction is all of steel and iron. The drum is cast in two sections and



bolted together. A sprocket for chain drive is bolted on sections around the middle of the drum. The frame is of steel channels and has 6x28-in. wheels. Steam engine and boiler, gasoline engine or electric motor can be furnished. The price is $450 without power loader and automatic tank.